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INTERNATIONAL JOURNAL OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

VOLUME 3
1959

International Journal
of
Bioclimatology and Biometeorology

Journal of the
„International Society of
Bioclimatology and Biometeorology"

VOLUME III
(1959)

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JOHNSON REPRINT CORPORATION
111 Fifth Avenue, New York, N.Y. 10003

JOHNSON REPRINT COMPANY LIMITED
Berkeley Square House, London, W.1

First reprinting, 1965, Johnson Reprint Corporation

Printed in the United States of America

GENERAL INFORMATION

The Journal is published by the "International Society of Bioclimatology and Biometeorology" and is printed in the Netherlands in off-set type.

PURPOSE OF THE JOURNAL

The "International Society of Bioclimatology and Biometeorology" covers in its journal the following subjects:

1. Summaries of completed bioclimatological studies which can be published in full by the authors in any other scientific journal;
2. Short reports on research in progress in order to stimulate team work between research workers in different parts of the world;
3. Critical reviews of special fields of bioclimatology;
4. A complete survey of world literature. Titles, names of authors and their addresses (if possible) are given; where possible, abstracts of important articles are also provided;
5. Summaries of Symposia or Congresses of National and International Organizations dealing with bioclimatological subjects;
6. Information on dates and programmes of Symposia and Congresses related to bioclimatological subjects;
7. Reports from the chairmen of the special scientific committees of the Society:
    a. Committee for the study of bioclimatological aspects of ALLERGIC DISEASES: secretary: Dr. D. Ordman (S. Africa). Two sub-committees:
        (1) Study of the indirect effect of meteorological factors on Allergic Diseases through pollen, spores and other allergens (Organized by Dr. D. Ordman, S. Africa);
        (2) Study of the possible direct effect of meteorological factors on Hay fever, Asthma and other Allergic Diseases (Organized by Dr. S.W. Tromp, Netherlands).
    b. Committee for ECOLOGICAL CLIMATOGRAPHY: Chairman Dr. H. Boyko (Israel). This committee is concerned with the definition of climate on the basis of the plant and animal associations of a region.
    c. Committee for INSTRUMENTATION: Chairman Dr. J.F. Griffiths (Great Britain). This committee compiles all available technical and economic data on instruments used in bioclimatological research.
    d. Committee for the study of possible biological effects of various types of IONISATION OF THE AIR: Chairman Dr. J.H. Kornblueh (USA); secretary Mr. John C. Beckett (U.S.A.).
    e. Committee of NAUTICAL BIOCLIMATOLOGY: Chairman Prof. F. Molfino (Italy); secretary Prof. V. Parodi (Italy).
    Two sub-committees:
        (1) Study of the physiological and pathological phenomena observed by ship surgeons (both naval and mercantile marine) in man and animals in various climates at sea.
        (2) Study of the influence of climate at sea on the living cargo in ships, so called CARGO BIOCLIMATOLOGY.
    f. Committee for the study of CHEMICAL TESTS, used in bioclimatological research in general and cosmic bioclimatology in particular: Chairman Prof. G. Piccardi (Italy); secretary Mrs. Eng. C. Capel-Boute (Belgium).
    g. Committee for the study of TROPICAL BIOCLIMATOLOGY: Chairman Dr. W.S.S. Ladell (Great Britain); secretary Mr. J.P. Nicolas (France).
    h. Committee on SOLAR RADIATION, in relation to biometeorology and bioclimatology: Chairman Prof. N. Robinson (Israel); secretary Miss Dr. Inge Dirmhirn (Austria)
8. Requests from both members and non-members for scientific information, about studies abroad, etc.;
9. Advertisements of private scientific firms of good standing.

Points 1 - 4 are dealt with in parts I - VI of each volume. Points 5 - 9 are dealt with in part VII.

Each year a new volume will be published, each volume being divided into seven parts and each part containing several sections. Depending on the material received and the funds of the I.S.B.B.

a number of sheets referring to various sections or parts of a volume will be sent at intervals to members. On top of each article the part and section number will be clearly indicated.

Each member will receive at the beginning of the year the cover of the volume for that year and the various coloured sheets separating the different parts.

The volume will be prepared in loose-leaved form, in order to facilitate the insertion of the sheets received in the corresponding parts or sections of the volume. At the end of the year, the member will be able either to keep the volume as one unit or alternatively the various parts can be separated and bound separately.
For this purpose a special printed white sheet, with the name of the Journal is supplied to members.

SUBSCRIPTIONS

Members of the Society receive the journal against payment of their yearly membership fee.
Non-members can obtain the journal against payment of 30 Dutch guilders per year, postage included.

EDITORIAL CORRESPONDENCE

Manuscripts submitted for consideration and all correspondence relating to editorial matters should be addressed to "the Executive Editor, International Journal of Bioclimatology and Biometeorology, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland".

MANUSCRIPTS

For preparation of manuscripts see "Instructions to Contributors" attached.

The Editors reserve the right to refuse any manuscript submitted, whether on invitation or otherwise, and to make suggestions and modifications before publication.

Articles accepted by the Editors remain the property of the International Society of Bioclimatology and Biometeorology, but may be reprinted in other scientific journals with the consent of the Editors of the Journal.

ADVERTISING

Companies in good standing may advertise in the Journal.
All correspondence should be addressed to the Executive Editor of the Journal, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland.

CONTENTS:

Each volume is divided into seven parts each of which is again subdivided into a number of sections as indicated below. Reports appertaining to one or more of these parts or sections will be sent to members at intervals according to the amount of data received by the Editor.

Sect. D : Urban bioclimatology
1. General urban bioclimatology
2. Architectural bioclimatology
3. Sanatorium bioclimatology
Sect. E : World literature

Part V : COSMIC BIOCLIMATOLOGY (grey cover)

Sect. A : General cosmic bioclimatology
Sect. B : Special cosmic bioclimatology
Sect. C : World literature

Part VI : PALEO-BIOCLIMATOLOGY (brown cover)

Sect. A : General paleo-bioclimatology
Sect. B : World literature

Part VII : MISCELLANEOUS BIOCLIMATOLOGICAL DATA (White cover)

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b. Ecological climatography
c. Instrumentation
d. Ionisation of the air
e. Nautical bioclimatology (General-, cargo bioclimatology)
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h. Solar Radiation
2. Literature
Sect. B : Symposia or congresses of national bioclimatological societies (dates, programmes, summaries of important lectures, decisions, etc.)
Sect. C : Bioclimatological stations and institutions
Sect. D : Requests from members
Sect. E : Requests from non-members
Sect. F : Book reviews
Sect. G : International Organizations (WMO, FAO, WHO, etc.)
Sect. H : Advertisements

DEFINITIONS:

As not all members may be acquainted with the various bioclimatological divisions outside their own speciality, the following list of definitions has been prepared:

BIOCLIMATOLOGY and BIOMETEOROLOGY (in general): comprises the study of the direct and indirect interrelations between the geo-physical and geo-chemical environment and living organisms, plants, animals and man. The term "environment" is broadly conceived and includes micro-, macro- and cosmic environments and the diverse physical and chemical factors which comprise these environments.
Investigations in these disciplines are conducted in nature or in the laboratory under as rigidly controlled conditions as possible to describe measurable and reproducible physical, chemical and biological factors which show a sufficiently high statistical correlation with measurable physiological and pathological processes to suggest a valid cause and effect relationship between organism and environment.

AEROSOL BIOCLIMATOLOGY: Study of the biological effects of aerosols (i.e. gaseous, liquid or solid aggregates floating in the air, with diameters of 1/1000 to 10 micron and consisting of hundreds to millions of molecules, often with either positive or nagative electrical charges).

PHYTOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate, weather and cosmic factors on plants.

ZOOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate, weather and cosmic factors on animals.

ENTOMOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate, weather and cosmic factors on insects and other terrestrial Arthropoda.

VETERINARY BIOCLIMATOLOGY: Study of the influence of climate, weather and cosmic factors on domestic and farm animals and birds and on animal products such as eggs, wool, milk, etc.

HUMAN BIOCLIMATOLOGY: Study of the influence of climate, weather and cosmic factors on man.

GENERAL PHYSIOLOGICAL BIOCLIMATOLOGY: Study of the influence of specific single or groups of meteorological components, of different climates (mountain-, marine-, forest climate, etc.) and of their seasonal variations on the various physiological processes of normal, healthy man.

GEOGRAPHICAL BIOCLIMATOLOGY: Study of the influence of geographical differences on the physiological processes of normal, healthy man.

ETHNOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate and weather on race and body structure of man.

ACCLIMATISATION BIOCLIMATOLOGY: Study of the adaptation of the human body to extreme climatological conditions.

SOCIAL BIOCLIMATOLOGY: Study of the influence of climate and weather on the social habits of man.

PSYCHOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate and weather on the mental processes of man.

AESTHETO BIOCLIMATOLOGY: Study of the influence of climate and weather on the aesthetic expression of man.

ARCHEOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate and weather on the origin, distribution and disappearance of past civilizations.

PATHOLOGICAL BIOCLIMATOLOGY: Study of the influence of climate and weather on the various physiological and pathological phenomena associated with the diseases of man.

METEOROLOGICAL PATHOLOGY: Study of the influence of specific single meteorological components (temperature, humidity, etc.) or groups of components on the origin and frequency of diseases and on the physiological phenomena of the diseases of man.

CLIMATOLOGICAL PATHOLOGY: Study of the influence of different climates (marine-, forest-, mountain-, etc.) and their seasonal variations on the origin and frequency of diseases and on the physiological phenomena of the diseases of man.

AIR POLLUTION PATHOLOGY: Study of the pathological influences of air pollution (either organic or inorganic particles or chemical substances) on man.

GEOGRAPHICAL CLIMATOPATHOLOGY: Study of the geographical distribution of diseases as a result of geographical differences in climate and in single or in groups of meteorological factors.

URBAN BIOCLIMATOLOGY: Study of the micro climates in houses and cities, their influence on the health of man, and of the methods of eliminating unfavourable influences and of increasing favourable biological effects in certain types of architectural construction and town planning.

SANATORIUM BIOCLIMATOLOGY: Study of the best location and construction methods of sanatoria from the point of view of climate and weather.

CLIMATOTHERAPY: Study of the therapeutic influence of certain climates and meteorological conditions on the diseases of man.

THALASSOTHERAPY (CLIMATOLOGICAL-): Study of the therapeutic influence of marine climates on man.

HELIOTHERAPY: Study of the therapeutic influence of solar radiation on man.

THERMOTHERAPY: Study of the therapeutic influence of various forms of heat on man.

AEROSOLTHERAPY: Study of the therapeutic influence of certain aerosols on man.

SOCIO-CLIMATOTHERAPY: Study of construction methods of schools, of location and construction of holiday camps for children and of other social aspects of life as a function of climate and weather and of the methods for improvement of the favourable climatological effects.

COSMIC BIOCLIMATOLOGY: Study of the biological effects of cosmic factors.

PALEO-BIOCLIMATOLOGY: Study of the influence of the climates of the past on the development and geographical distribution of animals and plants on earth.

ECOLOGICAL CLIMATOGRAPHY: Study of the definition of climate on the basis of plant and animal associations.

NAUTICAL BIOCLIMATOLOGY: Study of the physiological and pathological phenomena observed by ship surgeons (both naval and mercantile marine), in man and animals in various climates at sea.

CARGO BIOCLIMATOLOGY: Study of the influence of climate at sea on the living cargo in ships (plants, fruits and animals).

I N S T R U C T I O N S   T O   C O N T R I B U T O R S

In the interests of uniformity, contributors are requested to adhere to the following instructions:

1. CORRESPONDENCE AND MANUSCRIPTS:

   All correspondence should be addressed to Dr. S.W. Tromp, Hofbrouckerlaan 54, Oegstgeest (Leiden), Netherlands.

2. PAPERS SUBMITTED TO THE JOURNAL:

   (a) Papers should be written in English, French or German. Manuscripts should be typed, on one side of the paper only, double-spaced, quarto-size, leaving top and left hand margins at least 2.5 cm.(one inch) wide.
   No underlining should be used in the text for words, titles etc., but CAPITAL LETTERS, or C A P I T A L   L E T T E R S   W I T H   D O U B L E   S P A C I N G between the letters should be employed.
   Manuscripts should be packed flat.

   (b) Dates should be in the form "5 February 1957" not "February 5th 1957".

   (c) All Latin specific names should be followed by the authority when the name is first mentioned in the text or tables.

   (d) Accurate details of experimental controls should be given in all cases.

   (e) Each article should begin with a short abstract of not more than 50 words, immediately after the title and author's name, preferably in 3 languages (English, French and Germen). It would be appreciated if each article could be concluded with a short summary containing the main conclusions.

   (f) Four copies of the complete text of each manuscript should be submitted.

   (g) Graphs and other illustrative material which can be reproduced in off-set print without additional expenses (i.e. graphs and diagrams drawn in jet-black Indian ink on strong white or transparent paper) are permitted without charge. However, additional material of this kind which requires special cliché work, e.g. photographs (see point 6), may be allowed at cost, at the discretion of the editors.

   (h) Proof-reading is done by the Editors.

3. REFERENCES

   Bibliographic references should be listed in alphabetic order at the end of the paper and continuous numbering should be used. After the title of the Journal quoted, the following particulars should be supplied: the number of the vol., part (if known), first and last page and finally, the year of publication.

   For example: 1. BROWN, A.B. : Insects and Weather - Proc. R. Ent. Soc. London, 54, 7, 3-10, 1954.

   2. LEE, D.H.K. : Climate and Economic development in the Tropics - Harper & Brothers Publ. Co, New York, 182 p., 1957.

   3. SMITH, P.O. : Influence of Aerosols on health - Int. J. Biocl. Biomet., 1, IV, Sect. C 6e, 20 - 25, 1958.

   References should be referred to in text as (1), (2) etc.
   Titles of Journals should be abbreviated, as much as possible, according to the World List of Scientific Periodicals, except that the English usage of capitals for adjectives should be followed in the titles of British and American periodicals.

4. TABLES:

   Tables should be set out on separate sheets and numbered in Arabic numerals. They should be supplied with headings and kept as simple as possible. They should be referred to in the text as "Table 2", etc.

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   Graphs and diagrams should be large enough to permit reduction to a size of 10 x 10 cm. (4

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In exceptional cases graphs or diagrams not complying to these rules can be redrawn for the author in the office of the Executive Editor at cost price.

6. PHOTOGRAPHS:

Photographs can be easily reproduced in off-set print but should be unmounted, glossy prints showing good detail and contrast, permitting reduction to a size 10 x 10 cm (4 x 4 inches) without affecting legibility. They should be numbered separately from the tables, graphs and diagrams and should be referred to in the text as "Photo 4" etc.

7. REPRINTS:

50 copies of articles accepted by the Editors will be supplied gratis. Further copies may be obtained at cost price:
If ordered before printing, the prices are as follows:
100 reprints: 3.00 guilders/page, each additional 50 copies at 1.15 guilder/page.
For example 200 reprints of a 5 page article will cost 5 x 5.30 = 26.50 guilders + postage.
If ordered after printing is completed the price will be:
100 reprints: 4.30 guilders/page, each additional 50 copies 1.15 guilder/page.
Thus 200 reprints of a 5 page article will cost 5 x 6.60 = 33 guilders + postage.

C L E A R I N G   H O U S E

1. Requests for reprints of articles mentioned in the bibliographic summaries should first be addressed directly to the authors. If no reprints are available the International Journal of Bioclimatology and Biometeorology can prepare photocopies at cost price (abt. 40 Dutch cents = 11 dollarcents per photocopy of $4\frac{1}{4}$ x $5\frac{3}{4}$ inches; or 60 Dutch cents = 16 dollarcents per photocopy of $5\frac{3}{4}$ x $8\frac{1}{2}$ inches; or microfilms per frame of 2 pages = 8 dollarcents. These prices may change during 1958 and do not include postage).
   The forms enclosed, duly signed, should be sent to the Executive Editor of the Journal, Hofbrouckerlaan 54, Oegstgeest (Leiden), Holland.
2. Requests from members concerning literature relating to research projects should be sent to the Executive Editor of the Journal who will try to compile all available references concerning the subject and will forward these to the person requesting the information.
   If considerable administrative work is involved in compiling the data requested by a member a special service charge may have to be paid by the requesting member.
   Requests from non-members are only handled against payment of a service charge.
   The Editorial Staff may deviate from this rule in special circumstances.

R E Q U E S T   F O R   P H O T O C O P I E S

INTERNATIONAL SOCIETY OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

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INTERNATIONAL JOURNAL OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

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RENBOURN, E.T., REID, A.M., GILLING, D.R.: A contribution to the physiology of damp cold an aspect of temperate climate, Part II. An investigation on clothed men under indoor conditions - I.J.B.B., III, IV A 4, 1959.

SARGENT, F. : World Meteorological Organization and International Society of Bioclimatology and Biometeorology to collaborate - I.J.B.B., III, VII G, 1959.

SCHOLZ, : Probleme der Bioklimatologie und des Stallklimas bei der Rinder- und Schweinehaltung, Program of Symposium Pössneck, Thüringen, D.D.R. (28-29 May 1959) - I.J.B.B., III, VII B, 1959.

SVORAD, D., WELLNEROVA, J. : Temperature and air humidity as factors influencing sleep and wakefulness - I.J.B.B., III, IV B 2, 1959.

TYCZKA, S. : World literature - human Bioclimatology (Polish references) - I.J.B.B., III, IV E, 1959.

WELLINGTON, W.G. : World literature - Entomological Bioclimatology - I.J.B.B., III, III D, 1959.

WELLNEROVÁ, J., SVORAD, D.: Participation of some meteorological factors on the determination of emotional reactivity - I.J.B.B., III, IV B 2, 1959.

WÓJTOWICZ, W. : Report on the Bioclimatological Conference in Ciehocinek (Poland) (30-31 October 1958) - I.J.B.B., III, VII B, 1959.

WORLD LITERATURE : General phytological bioclimatology; general agricultural bioclimatology; agricultural phenology; forest bioclimatology; physiological bioclimatology - I.J.B.B., III, II F, 1959.

WORLD LITERATURE : General zoological bioclimatology; physiological zoo-bioclimatology ; entomological bioclimatology; veterinary bioclimatology - I.J.B.B., III, III D, 1959.

WORLD LITERATURE : General human bioclimatology; gen. physiological bioclimatology; acclimatization bioclimatology - I.J.B.B., III, IV E, 1959.

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GENERAL BIOCLIMATOLOGY

(1959)

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GENERAL BIOCLIMATOLOGY
Section F: Miscellaneous data
(Possible causes of Bioclimatological effects)

DAS PROBLEM METEORO-BIOLOGISCHER BEZIEHUNGEN IM LICHTE MIKROBIOLOGISCHER FORSCHUNG

von

Dr.H. Bortels (Germany) *

Seit einigen Jehrzehnten finden die schon im Altertum bekannten, heute als Wetterfühligkeit und Wetterempfindlichkeit oft erwähnten Beziehungen zwischen physiologischen und psychologischen Reaktionen des Menschen einerseits und meteorologischen und solaren Prozessen andererseits wieder allgemeine Beachtung und intensive wissenschaftliche Bearbeitung. Ausführliche Berichte wurden u.a. von PETERSEN (43), DE RUDDER (53), DÜLL (26), BERG (4), CURRY (25) und ASSMANN (2) veröffentlicht. Der Mensch steht im Mittelpunkt dieser Forschung. Deshalb wird in fast allen zu diesem Problem aufgestellten und grösstenteils wieder verworfenen Theorien über die Kausalkette das Nervensystem als Rezeptor eines mit Wetteränderungen verknüpften, nicht näher bekannten und verschieden gedeuteten Reizes genannt. Hierzu und zu anderen Teilen des Gesamtproblems soll im folgenden aus mikrobiologischer Sicht Stellung genommen werden. Die Mikrobiologie geniesst dabei den Vorzug, dass ihre verhältnismassig einfach gebauten Objekte im Experiment leichter und auch eindeutiger befragt werden können als höher organisierte Lebewesen wie der Mensch.

Vor etwa 30 Jahren wurde von BORTELS (7) festgestellt, dass Einzeller auf bevorstehende oder gleichzeitig ablaufende Wetteränderungen reagieren. Die ersten Versuchsreihen über mehrere Jahre ergaben auffallende, aber in ihrer Signifikanz damals nicht mit statistischen Methoden geprüfte Korrelationen zwischen verschiedenen Lebensäusserungen einiger Bakterien und Pilze und meteorologischen Ereignissen wie Änderungen der Bewölkung und vor allem des Luftdrucks (8). Bei abnehmender Bewölkungsdichte nahm die Beweglichkeit mehrerer verschiedener Bakterienarten gleichzeitig zu und bei zunehmender Bewölkungsdichte und Niederschlägen nahm sie bis zur völligen Ruhe ab. Bei antizyklonaler Wetterentwicklung vermehrten sich z.B. aerobe Bakterien schneller, leuchteten Kulturen eines Leuchtbakteriums stärker, kopulierten verschiedene Mikroorganismen zahlreicher und liessen Sporangien von Phytophtora infestans weit mehr Zoosporen schlüpfen als bei zyklonaler Wetterentwicklung. Anaerobe Mikroorganismen reagierten dagegen umgekehrt, indem die von ihnen ausgelösten Reduktionen und Gärungen, z.B. die CO_2-Bildung durch Hefe, bei zyklonalen Wetterentwicklungen intensiver verliefen als bei antizyklonalen. Dabei befanden sich die Objekte bei konstanter Temperatur und Feuchtigkeit und zum Teil auch in hermetisch verschlossenen Gefässen im dunklen Thermostaten.

Soweit sich Ergebnisse dieser Art bestätigen und sichern liessen (16,17,18), sind also irgendwelche Reizwirkungen, ausgehend von Änderungen bekannter Faktoren wie Licht, Temperatur, Feuchtigkeit und Druck, zumindest für die betreffenden Organismen von vornherein aus dem Kreis der Betrachtungen auszuschliessen. Ferner kann das Nervensystem des Menschen oder der Tiere nicht länger als erster und einziger Resonanzort für das unbekannte exogene Agens angesehen werden. Ausser bei Bakterien wurden wetterbezogene Reaktionen bei Pilzen (32) und Algen (37, 38) auch von anderen Autoren festgestellt. Hier handelt es sich aber ebenfalls um nicht gesicherte Feststellungen. Immerhin liegt schon eine gewisse Sicherung in der Bestätigung von Einzelbefunden durch verschiedene Autoren an verschiedenen Objekten. BORTELS (10,11) hatte aus seinen Versuchsergebnissen geschlossen, dass Maxima von Oxydationen, aerober Atmung, generativer Vermehrung und Beweglichkeit bei Bakterien und Pilzen im Laboratorium meistens mit steigendem, Minima mit fallendem Luftdruck verbunden sind und umgekehrt Maxima von Reduktionen, Gärungen, Aggregationen und vegetativem Wachstum mit fallendem und ihre Minima mit steigendem Luftdruck. Entsprechende Feststellungen machte später KISS (37,38) bezüglich des Verhaltens von Mikroorganismen der sog. Wasser- und Schneeblüten. Die vegetative Massenvermehrung der diese Erscheinung hervorrufenden Algen auf Grund der Assimilation, also Reduktion der Kohlensäure, erfolgte bei fallendem und die Gametenbildung bei steigendem Luftdruck. In jüngster Zeit haben BROWN und Mitarbeiter (20) be-

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richtet, dass verschiedene Arten höherer und niederer Tiere und Pflanzen unter weitgehend konstanten Versuchsbedingungen einschliesslich Druck in ihrem Sauerstoffverbrauch und ihrer Beweglichkeit parallel zu Luftdruckänderungen exogen beeinflusst werden.

Es gibt jedoch auch Arbeiten, die diese bisher genannten Feststellungen zu widerlegen scheinen. So hat JENSEN (34) die von BORTELS (7) festgestellte Beziehung zwischen AZOTOBACTER -Entwicklung und Luftdruckänderung, nämlich intensive Stickstoffbindung mit entsprechender Entwicklung vor und bei steigendem, schwache oder gar keine vor und bei fallendem Luftdruck, nachgeprüft und keine derartige gesicherte Beziehung gefunden. Dasselbe gilt für die Nachprüfung der von BORTELS (10) behaupteten Abhängigkeit der Nitrifikation vom Wetter durch STÜVEN und ENGEL (54), die nur eine Korrelation zwischen Oxydationsmaxima und steigendem Luftdruck, nicht aber auch zwischen Minima und fallendem Luftdruck feststellen konnten. Möglicherweise war jedoch in diesem Falle die Versuchszeit zu kurz (3 Monate), und in beiden Fällen die Untersuchungsmethode nicht sehr geeignet, worauf die Autoren z.T. selbst hingewiesen haben. Mindestens ebenso wichtig für die Deutung dieser Widersprüche ist die Tatsache, dass JENSEN 1948/49 experimentiert hat, als auch BORTELS (z.B. 11) keine deutlichen Beziehungen der AZOTOBACTER-Entwicklung und anderer mikrobiologischer Reaktionen zu Luftdruckänderungen feststellen konnte. Dagegen hat er sie 1950/51 wieder nachweisen können. Das hat sehr wahrscheinlich seinen Grund in der veränderlichen Sonnenaktivität. Schon die ersten Reihenexperimente, die BORTELS (7) mit AZOTOBACTER als Versuchsobjekt angestellt hat, lassen deutlich erkennen, dass die jährliche Durchschnittsmenge gebundenen Luftstickstoffs von 1933 = 15,8 mg über 1934 = 13,0 mg und 1935 = 11,6 mg bis 1. Vierteljahr 1936 = 11,6 mg bei zunehmender Sonnenaktivität abnahm. Ueberdies wurden die kurzfristigen Schwankungen in der Menge des gebundenen Stickstoffs kleiner und standen seit Winter 1934/35 mit zunehmender Zyklonentätigkeit nicht mehr in so deutlicher Korrelation zu Wetteränderungen wie 1933. Später wurden solche Ueberlagerungen des Wettereinflusses durch den Sonneneinfluss in bestimmten Jahren und Jahreszeiten auch bei anderen Objekten festgestellt, nämlich beim Gefrieren unterkühlten Wassers und beim Erkranken von Tabak nach Infektion mit PSEUDOMONAS TABACI (11,13,17). Dass die periodischen Schwankungen der Sonnenaktivität mit Lebensvorgängen unmittelbar in Beziehung zu bringen sind, ist an mancherlei Objekten von verschiedenen Autoren gezeigt worden, obwohl auch hier vieles nicht ausreichend gesichert ist. Es genügt, wenn in diesem Zusammenhang auf die kritischen Betrachtungen von BERG (5) verwiesen wird. Auf Grund der allerdings noch mangelhaften Erfahrungen auf diesem Gebiet scheinen die Beziehungen mikrobiologischer Reaktionen zu Luftdruckänderungen immer dann am deutlichsten zu sein, wenn die Fleckenaktivität der Sonne langsam abnimmt oder ein Minimum erreicht, und am undeutlichsten bei der raschen Zunahme und im Maximum der Fleckentätigkeit.

Inzwischen hat sich gezeigt, dass die zeitliche Abstände zwischen biologischen und zugehörigen meteorologischen Ereignissen nicht immer konstant sind, also z.B. bei der Verwendung der Synchronisations- oder "n"-Methode in den mittleren Luftdruckdifferenzkurven um die biologischen Stichtage "n" manchmal Phasenverschiebungen vorkommen (16,17). Deshalb können bei der statistischen Auswertung einer grösseren Zahl von Einzelfällen mit einigen zeitlich abweichenden Reaktionsabständen tatsächlich vorhandene meteorobiologische Beziehungen durch Interferenz ausgelöscht werden. Da sich während des steilen Anstiegs der Sonnenfleckenkurve die Verhältnisse entsprechend schnell ändern, ist es schon deshalb verständlich, warum in dieser Phase des Fleckenzyklus die Beziehungen biologischer Reaktionen beispielsweise zu Luftdruckänderungen im Synchronisationsverfahren weniger deutlich in Erscheinung treten als während des allmählichen Abfalls der Fleckenkurve. Ausserdem tritt bei dem betont zyklonal turbulenten Wetter vor und in einem Fleckenmaximum während der ganzen Zeit oft nur ausschliesslich und gleichbleibend der zum Tiefdruckwetter gehörige Typ einer biologischen Reaktion auf, wie auch umgekehrt der zu Hochdruckwetter gehörende Typ nach dem Fleckenmaximum während des Maximums der erdmagnetischen Aktivität in gleichbleibender Stärke vorherrscht, weil weitere Steigerungen bei der Natur des Objektes nicht möglich sind (12,15).

Neben diesen Störungen in den genannten Korrelationen zwischen den Reaktionen der Versuchsobjekte und meteorologischen Vorgängen soll noch eine weitere Erwähnung finden, die besonders wichtig erscheint. Zuvor aber ist es nötig, ausdrücklich darauf hinzuweisen, dass nicht nur lebende Zellen, sondern auch unbelebte physikalisch-chemische Systeme von dem Wetteragens in entsprechend verschiedener Weise je nach zyklonaler oder antizyklonaler Wetterentwicklung beeinflusst werden. BORTELS (12) hat beim Ansetzen von Nährlösungen bemerkt, dass Niederschläge von Calciumphosphat bei zyklonalen Wetterentwicklungen schnell und grossflockig ausfallen, bei antizyklonalen dagegen langsamer, in feinkörnigen Streifen. Ähnlich verhält es sich mit der Synarese von Agar, Serum (10), Arsentrisulfid (31,41), Blut (23,44) und anderen hydrophilen Kolloiden (42, 45,47), deren Teilchen bei zyklonalem Wetter leichter aggregieren als bei antizyklonalem. Beziehungen zur Sonne sind besonders deutlich gesichert von PICCARDI und anderen (3,22,47) an der wechselnden Sedimentationsgeschwindigkeit bei der Wismutoxychlorid-Fällung nachgewiesen worden. Es kann folglich auch nicht überraschen, dass Kristallisationen aus übersättigten Lösungen und das Gefrieren kleiner Mengen unterkühlten Wassers gleichfalls solche Wetterabhängigkeiten zeigen. 5 ml in Ampullen eingeschmolzenen Wassers gefrieren bei -6° C vor und bei steigendem Luftdruck leichter als vor und bei fallendem Luftdruck (12,13). Aus allen diesen Feststellungen muss

geschlossen werden, dass das unbekannte meteorobiologische Agens uber mikrophysikalische Reaktionen in der Zelle oder ihrer nächsten Umgebung zur Wirkung kommt. Diese Wirkungen sind nicht nur biologisch von Bedeutung, sondern spielen auch im Bereich der Technik eine Rolle (18,40).

Bei den Versuchen mit unbelebten, also extrem einfachen Systemen, liessen sich deren Beziehungen zu meteorologischen Vorgängen durchweg signifikant nachweisen. Hier hat sich auch besonders klar herausgestellt, welche Bedeutung verschiedener, räumlich über den Versuchsobjekten vorhandener Materie zukommt. Nach TZSCHASCHEL und BERGTER (56) ist die Wirkung der über dem Versuchsobjekt vorhandenen, vermutlich als Absorber oder Reflektor wirkenden Materie abhängig von ihrer Masse nach Art einer ROSSI-Kurve. PICCARDI (46) dagegen macht die Wirkung nicht von der Masse, sondern von der spezifischen elektrischen Leitfähigkeit des Materials abhängig. Er findet dünnes Kupfer wirksamer als dickes Blei. Doch ist noch nicht sicher, ob das immer zutrifft. Jedenfalls müssen bei allen Experimenten etwa vorhandene Absorber oder Reflektoren gebührende Beachtung finden. In nächster Nähe des Objektes sind sie kontrollierbar. Andere aber sind es nicht immer, z.B. die Dunstglocke über einer Stadt (16) oder sonstige atmosphärische Qualitäten und ihre Veränderungen. Sie kommen als Störungsursachen für synchrone meteorobiologische Untersuchungen an verschiedenen Orten in Betracht.

Das also das Wetteragens nachweislich nicht nur lebende, sondern auch unbelebte Materie in wässriger kolloidaler oder echter Lösung beeinflusst, war nicht nur eine unmittelbare Wirkung auf Mikroorganismen, sondern auch eine mittelbare über das Nährsubstrat von vornherein anzunehmen. Tatsächlich liess sich diese Annahme verschiedentlich bestätigen (14,15,16,17,18). Physiologische und morphologische Eigenschaften von Mikroorganismen werden dadurch verändert, dass das für sie bestimmte Nährsubtrat bei seiner Auflösung in Wasser vom Wetteragens in charakteristischer Weise beeinflusst wird. Dieser Enfluss ist wie der unmittelbar auf die Zellen erfolgende so, dass die Lösung unter zyklonalem Wettereinfluss umgekehrte Wirkungen auf die sich in solchem Substrat entwickelnden Mikroorganismen zur Folge hat wie die Lösung unter antizyklonalem Wettereinfluss. Die Wirkung kommt wahrscheinlich so zustande, dass entsprechende Stoffwechseltypen einer Bakterienpopulation auf oder in dem durch das Wetteragens in der einen oder anderen Weise veränderten Substrat einen Selektionsvorsprung erhalten und so die Eigenschaften der ganzen Kultur prägen. Natürlich können auch bei Nichtbeachtung dieser Wirkungen vorhandene meteorobiologische Beziehungen durch Ueberlagerung der beiden verschiedenen Einflussmöglichkeiten infolge Interferenz mehr oder weniger ausgelöscht werden. Hierin liegt eine weitere und, wie mir scheint, eine der wichtigsten Störungsursachen, die bisher keine Beachtung gefunden und zu Kontroversen über die Realität meteoro-mikrobiologischer Beziehungen geführt hat.

Der Substrateinfluss des Wetteragens auf die Farbstoffbildung einiger CHROMOBACTERIUM-Arten und anderer Mikroorganismen konnte so weit geklärt werden, dass nunmehr in diesem mikrobiologisch wichtigen Prozess nahezu experimentelle Unabhängigkeit vom Wetteragens besteht. Das bei den einschlägigen Versuchen verwendete Nährsubstrat enthielt ausser Glucose und Pepton Dikaliumphosphat, Magnesiumsulfat, Ferrosulfat und Calciumcarbonat. Die noch nicht veröffentlichten Versuchsergebnisse haben bewiesen, dass der Einfluss des Wetteragens auf CHROMOBACTERIUM VIOLACEUM und anderen Mikroorganismen über den Nährboden nur dann sehr deutlich zu erkennen ist, wenn die Salze für jeden Versuch frisch in Wasser gelöst werden. Diese Forderung gilt nicht in gleichem Masse für die organischen Komponenten des Substrats. Die Wetterentwicklung muss also vornehmlich über die anorganischen Bestandteile verlaufen. Eine getrennte entsprechende Untersuchung der 4 Salze ergab, dass das Phosphat vor Magnesium- und Ferrosulfat den wesentlichsten Faktor darstellt. Es sei daran erinnert, dass Calciumphosphat je nach Wetterentwicklung schneller oder langsamer, grobflockig oder feinteilig streifig ausfällt. Es ist anzunehmen, dass auch mit Magnesium- und Eisenphosphat ähnliches geschieht. Da unter zyklonalem Einfluss, wenn Phosphat grobflockig ausfällt, CHROMOBACTERIUM VIOLACEUM auf entsprechendem Nährboden rauh und tief violett wächst, wäre theoretisch dasselbe infolge einer Verminderung der Phosphatkonzentration und damit der Zuckerphosphorylierung und Atmung zu erwarten. Tatsächlich trifft das auch bis zu einem gewissen Grade zu. Farbstoffbildung ist oft eine Folge gehemmter Kohlehydratatmung und verstärkter Eiweissatmung (Autolyse). Die Kulturen wachsen seit einigen Jahren mit sehr wenig Phosphat rauh und tief violett und mit viel Phosphat glatt und heller violett, jedoch nicht farblos. Das farblose Extrem wird zur Zeit bei den reduktionsbegünstigenden starken Tiefdruckwirkungen (15) erst dann erreicht, wenn dem Nährboden ausser viel Phosphat ein Oxydationsmittel wie etwa Chinon in geeigneter Konzentration zugesetzt wird. Entsprechend können bei starken oxydationsbegünstigenden Hochdruckwirkungen tief violetten Kulturen auf demselben Substrat nur dann erzielt werden, wenn ihm ausser extrem wenig Phosphat ein Reduktionsmittel wie etwa Sulfit zugesetzt wird. Dieselben Beziehungen zwischen Populationswechsel (Selektion morphologisch und physiologisch verschiedener Typen) und Atmungs-stoffwechsel haben in ganz anderem Zusammenhang auch ALTENBERN und Mitarbeiter (1) gefunden. Die Substratwirkungen des Wetteragens scheinen also ebenfalls sowohl über Fällungen als auch über Oxydationen und Reduktionen, und zwar über Beeinflussungen der Atmung zu verlaufen, entsprechend dem eingangs erwähnten Wirkungsunterschied zwischen zyklonalen und antizyklonalen Wetterentwicklungen. Die sich aufdrängende Frage, ob dieser Wirkungsmechanismus auch für die unmittelbare Beeinflussung des Zellinneren durch das unbekannte Wetteragens gilt, bedarf noch weiterer Untersuchung und Klärung.

Nachdem somit im Verlauf mikrobiologischer und physikalisch-chemischer Experimente eine Reihe von Störungsfaktoren bekannt geworden sind, wird es unter Beachtung dieser Erkenntnisse nunmehr möglich sein, noch stichhaltigerere Beweise für die Existenz meteoro-biologischer Beziehungen zu liefern. Das ist unter anderem auch für die epidemiologische Forschung besonders wichtig. Hier sei ein Wort zum Grundsätzlichen im meteoro-pathologischen Geschehen erlaubt: Unter dem Einfluss zyklonaler Wetterentwicklung können aerobe Organismen, auch der Mensch, in ihrem Stoffwechsel und der Funktion ihrer Organe gehemmt werden. Diese Organe können dann auch erkranken (4, 25, 26, 43, 53). Fällungen, z.B. im Blut, sind dann stark begünstigt, die Gefahr von Thrombosen ist erhöht (23, 44). Folgt nun antizyklonales Wetter, dann tritt in jeder Beziehung das Gegenteil ein. Der Stoffwechsel wird intensiver, die Organe erholen sich, Thromben lösen sich und können Embolien hervorrufen. Das wird durch zahlreiche korrelationsstatistische Untersuchungen belegt (23,33). Diese Abhängigkeit der Atmung und Stoffwechselintensität gilt aber auch z.B. für aerobe parasitische Bakterien, mit dem Unterschied allerdings, dass sie als Einzeller anscheinend schneller reagieren. So treffen beim Uebergang von zyklonalem zu antizyklonalem Wetter schon aktivierte Bakterien auf noch nicht abwehrbereite Wirtsorganismen und machen diese krank. Wenn dann aber wieder der Uebergang zum zyklonalen Wetter erfolgt, können sich die nun schon geschwächten Bakterien des inzwischen stark gewordenen und noch anhaltend starken Gegenangriffs des Wirtsorganismus nicht mehr erwehren, und die Infektionskrankheit kann heilen, die Seuche erlöschen. Diese Erkenntnisse wurden aus den Ergebnissen von Modell-experimenten mit menschlichem Speichel und einem saprophytischen Bakterium abgeleitet (9) und fanden bis jetzt sowohl durch Versuche mit pflanzenpathogenen Bakterien (17) als auch durch statistische Untersuchungen an umfangreichem Material von Infektionskrankheiten des Menschen (28) weitgehende Bestätigung. Ebenso fügt sich die Feststellung von TSCHESCHE und Mitarbeitern (55) über die Bildung von Peroxyden als Bakterieninhibine im menschlichen Speichel gut in den allgemeinen Rahmen der gegebenen Theorie ein. Anaerobe pathogene Bakterien und die von ihnen hervorgerufenen Krankheiten stehen selbstverständlich in anderer Beziehung zum Wetterverlauf als die Aeroben, und auch Viren scheinen sich anders zu verhalten. PRIMAULT (49,50) hat z.B. festgestellt, dass die spontanen Ersterkrankungen an Maul- und Klauenseuche unter Berücksichtigung der Inkubationszeit mit einem markanten Luftdruckfall verbunden sind, und CORDES (24) fand dasselbe für die Grippe. Wenn alle diese verschiedenen Wirkungen des unbekannten Agens auf Wirt und Parasit berücksichtigt werden, dann können auch die Beziehungen des Seuchengeschehens zu meteorologischen Ereignissen deutlicher hervortreten.

Natürlich hat trotz Klärung so mancher Teilfragen vieles noch ungeklärt bleiben müssen. Auch die Kernfrage nach dem wirksamen Agens kann z. Zt. noch nicht beantwortet werden. Alles, was hierzu von mikrobiologischer und physikalisch-chemischer Seite festgestellt werden konnte, deutet auf Strahlung, deren totalen Abschirmung bisher nicht gelungen ist, auch nicht 1000 m unter der Erdoberfläche. Beziehungen zur Sonnenaktivität, zeitlich weltweite Uebereinstimmung bestimmter Reaktionen (12,47,57), Sonnenrichtungs- und Abschirmeffekte (12,44,46), Tages- und Jahreszeitenrhythmen (7, 12, 47) und manches andere sprechen für eine variabele Sonnenstrahlung, die nach DÜLL (27) und KOPPE (39) sowohl das Wetter (Luftdruck) als auch nach mancherlei Umwandlung in der Atmosphäre das Leben auf der Erde beeinflusst. Auch haben u.a. EUGSTER und HESS (30), TZSCHASCHEL und BERGTER (56) sowie KELENTEY und KELETI (35) biologische Wirkungen der kosmischen Strahlung und ihrer Schauer hinter Blei nachgewiesen. Die Schwankungen des P-Testes nach PICCARDI (45) korrespondieren mit denen der kosmischen Strahlung. Bakteriennährböden können nach WYSS und Mitarbeitern (58) durch UV- und Röntgenstrahlen in ähnlicher Weise beeinflusst werden wie durch antizyklonale Wetterentwicklung. Nach BROWN und Mitarbeitern (19) bestehen gesicherte Beziehungen zwischen der Atmungsgrösse und Intensität der Umgebungsstrahlung, die nach BORTELS (15) z.B. auch zum Phosphat-Fällungstyp in Beziehung steht. Es ist nun nötig, dass in dieser Richtung weiter vorgestossen und das Problem noch enger eingekreist wird. Möglichkeiten hierzu sind beim Experimentieren mit mikrobiologischen und physikalisch-chemischen Objekten durchaus vorhanden. Man sollte versuchen, von Einzelmessungen zu laufenden Registrierungen überzugehen, wie es NEUWIRTH (41) schon mit Erfolg versucht hat, damit auch kurzfristige Ereignisse und das Verhalten während der Nacht erfasst werden. BERGTER und NOACK (6) halten das noch unbekannte meteoro-biologische Agens auf Grund ihrer Experimentalergebnisse für Korpuskularstrahlung. Sie nehmen zwei verschiedene, positiv und negativ geladene Teilchen mit verschieden grosser Durchdringungsfähigkeit an. Die negativen Korpuskeln könnten für die zyklonalen und die positiven für die antizyklonalen Wirkungen verantwortlich gemacht werden. Jedoch gibt es noch kein physikalisches Messverfahren für diese Teilchen, so dass also ihre Existenz noch nicht sicher bewiesen ist. Manche andere Versuchsergebnisse, z.B. zeitliche Uebereinstimmungen mit magnetischen Stürmen, von TAKATA (57), BORTELS (11,15), PICCARDI (45,46) und BURKARD (22) sprechen aber ebenfalls dafür. DÜLL (26), KIEPENHEUER und Mitarbeiter (36), BRUZEK (21) und REITER (52) nehmen dagegen Wellenstrahlung als Ursache an. Korrelationen zwischen dem Auftreten von Infralangwellen (51) und bestimmten biologischen Reaktionen oder die Wirkung elektrischer Felder im Experiment (48, 52) sind aber noch kein schlüssiger Beweis dafür, dass Feldstrahlung auch immer die meteorobiologischen Reaktionen unmittelbar auslöst. ELMERT und Mitarbeiter (29) haben die Versuchsergebnisse von KIEPENHEUER und Mitarbeitern nicht bestätigen können, und auch BORTELS konnte bisher keine Wirkung von cm- und m-Wellen auf die von ihm geprüften Objekte feststellen. Möglicherweise

könnte es daran liegen, dass das Auftreten bestimmter Wellenstrahlen nur ein dem Agens parallel geschaltetes Symptom wäre, oder dass die genannte Teilchenstrahlung als Agens durch elektrische Felder verändert wird, oder auch dass für verschiedene Versuchsobjekte und Reaktionen verschiedene Agentien, teils Wellen, teils Korpuskeln, in Betracht kommen. Alle diese grundsätzlichen Fragen sind jetzt einer erfolgversprechenden Bearbeitung mit Hilfe mikrobiologischer und physikalisch-chemischer Versuchsobjekte besser zugänglich geworden, und es ist zu hoffen, dass auf diesem Wege bald weitere Ergebnisse erzielt werden.

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GENERAL BIOCLIMATOLOGICAL DATA

Section F: Miscellaneous data

PRELIMINARY RESEARCH ON THE TRANSPARENCY OF THE ATMOSPHERE AT BYDGOSZCZ

by

Dr. J. Paszyński (Poland)*

During the latter part of 1955 the intensity of direct solar radiation was investigated at Bydgoszcz.

The object of this study was to determine the influence of the urban environment upon the transparency of the atmosphere. Measurements were carried out simultaneously in several parts of the town by means of Gorczyński actinometers. The results obtained were the basis for calculation of the value of the new turbidity factor Θ (according to F. Linke).

In addition to the differentiation of atmospheric transparency in the town area, resulting from air pollution by industrial smoke, the existence of a characteristic diurnal variation of the turbidity factor Θ was also found. The highest values of Θ were observed in the morning and evening, whereas a minimum was reached at noon, as is clearly shown in the diagram attached.

The curve shown differs distinctly from the variation diagram of Θ quoted by F.Linke ("Handbuch der Geophysik", VIII) for Frankfurt a/M., which is situated in similar conditions to those at Bydgoszcz. However, it should be mentioned that Linke's diagram relates to the summer months.

On the basis of W.G. Kastrow's data and according to the formula of F. Möller, the share in atmospheric extinction of the following factors has also been calculated: 1. molecular scattering, 2. selective absorption due to water vapour and 3. scattering and absorption by aerosols. The following table shows the relative share of each of the three above mentioned factors at noon only on a few related days during the period under discussion. The value of the molecular scattering has always been accepted as 1.

Relative Share of Water Vapour (d_vI) and Aerosols (d_aI) in Atmospheric Extinction at Bydgoszcz, compared with Molecular Scattering (d_mI)

date	d_vI	d_aI
9 September 1955	1.04	1.50
12 September 1955	0.93	1.70
21 September 1955	0.86	1.82
25 September 1955	0.93	0.90
30 September 1955	0.83	0.57
2 October 1955	0.80	0.97
3 October 1955	0.74	0.77
4 October 1955	0.84	0.77
12 October 1955	0.79	0.61
19 October 1955	0.69	0.74

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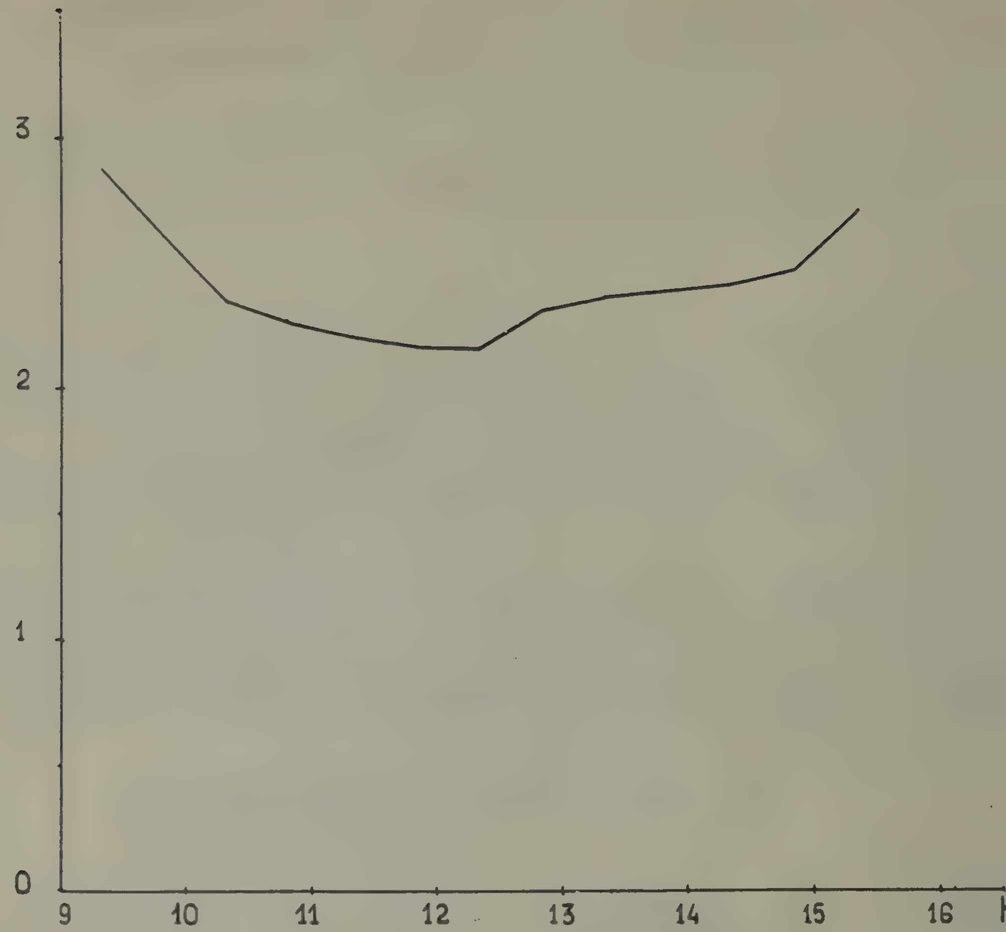
This article could be classified also under part IV, Section C4c: Chemical pollution.



Average Diurnal Variation of the Turbidity Factor Ⓗ
at Bydgoszcz in September and October 1955.

Section G : World literature

PART II

PHYTOLOGICAL BIOCLIMATOLOGY

(1959)

Section A : General phytological bioclimatology

Section B : Agricultural bioclimatology

1. General agricultural bioclimatology
2. Agricultural phenology

PHYTOLOGICAL BIOCLIMATOLOGY

Section B1: General agricultural bioclimatology

SEAWATER IRRIGATION

A NEW LINE OF RESEARCH ON A BIOCLIMATIC PLANT- SOIL COMPLEX

by

Dr. Hugo and Elisabeth Boyko (Israel) *

I. REPORT ON PRINCIPLES AND PRELIMINARY EXPERIMENTS

In the following paper an experiment is described in which two plant species with extremely different ecological requirements were successfully grown on dune sand under direct irrigation, with various dilutions of seawater, during a period of approximately 1½ years. This experimental period included two seasons of drought, one of about three months before the winter rains of 1957/58, and one of almost nine months between the winter rains of 1957/58 and 1958/59.

This experiment was carried out in order to test our theory that the direct use of seawater for irrigation is possible in many cases, provided that accumulation of salts, particularly NaCl, or the domination of sodium and chloride ions in the root layer can be prevented.

According to an extensive review organized by Unesco on "Utilization of saline water" (23) based on a bibliography of hundreds of papers and books, this appears to be the first experiment of its kind. In this review, in the chapter on "Regional Climatic Problems", water of marine origin is also mentioned. One sentence is all that is said; namely: that in this case the real problem is not how to use, but how to get rid of this saline water (23a, p. 21).

Before describing our experiment, it is therefore justified for us to deal not only with the underlying scientific principles, but also to show their gradual development and stages.

2. HISTORY

Many trials have been carried out with salt water, possibly since prehistoric times, when man first started to irrigate crops in the neighbourhood of salty waters by flooding fields in arid regions. Archeological records excavated by H. Helboek in Irak and numerous other data elucidate the gradual salination of alluvial soils there during a period of about 2000 years.

It is worthwhile quoting in this connection, one of the "parallel lines of evidence".

Pottery excavated from sites in Southern Irak dating from about 3500 B.C. suggest that at that time the proportions of wheat to barley were nearly equal.

A little more than 1000 years later, the less salt-tolerant wheat accounted for only one-sixth of the crop - and in 2100 B.C. for even less than 2 per cent. By 1700 B.C. the cultivation of wheat had been abandoned completely. The average yield had shrunk from 2537 litres per hectar in about 2400 B.C. to an average of only 897 litres per hectar about 700 years later (1700 B.C.).

This information may throw new light also on the existence of the abandoned cities and settlements in the Negev. It also supports the suggestion that there have been no large climatic changes during the last 3000 years in these desert parts of Israel, now in process of reclaimation.[1]

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For reasons of economy all photographs are printed at the end of this paper.

1) See also H. Boyko (6) and the discussion on climate fluctuations at the UNESCO-Symposium on Hydrology in Ankara, 1952.

In those times, salination of the once fertile soils was, in itself, enough to cause increasing poverty and depopulation, not to speak of the numerous wars to win new arable lands.

It is surprising enough that salination was already detected in those early times; but to prevent it was an unsolvable problem then. In such arid areas fields of wheat and barley are flooded up this day by collecting the run off waters and leading them onto terraced fields. Direct precipitation alone does not suffice. The damage caused to agricultural soils by flooding with seawater however was always catastrophic and known as such.

It is therefore understandable that, after these unfortunate experiences for thousands of years, man apparently never conceived the idea of using salt water in just those areas of the barren shifting sand dunes where, even without such dangerous irrigation, almost nothing could grow.

For this purpose a synoptic and synthetic approach, such as ecology has adopted during these last few decades, was essential.

We feel obliged however to stress the true importance of our simple experiment and deprecate the sensational storm that was created in the world press (see also 11).

We connected well-known geophysical principles with well-known phytobiological principles. We combined general climatic data and meteorological measurements of wind, spray-salt and sand movement. Furthermore the figures of temperature, drought and precipitation were linked with the physical phenomena of rapid percolation and good aeration in sand dunes on the one hand, and the recognized phytobiological phenomena of slower water intake by roots in saline solutions, higher osmotic pressure, etc., on the other.

Instead of proceeding step by step, increasing salinity and taking normal agricultural soil as our mainstay, we adopted a new approach in our experiments. We began from the other extreme; namely, with the highest amount of seawater, the highest available concentration through the longest possible dry period and on the most barren places, the shifting sand dunes.

3. FORMER STUDIES

The idea which prompted the following experiment was based on various previous studies. We had carried out similar and extensive studies in the "Sand- and Salt-Steppes" of the "Neusiedler-See" in Burgenland, Austria, during the years 1929 - 1935 (4,5,7), and supplemented them by many additional investigations on the coasts of the Baltic Sea, the North Sea, and on many parts of the Mediterranean Coast. Many observations on halophytic and psammophytic plant communities were also made in Germany, Southern France, Anatolia, South West Asia, Egypt and, since 1936, extensively in Israel. These have shown that islands of non-halophytic plant communities frequently thrive in the midst of areas of pure halophytic vegetation. Closer investigations has made it clear that the soil in these islands is of a sandy or a gravelly texture or else percolation is facilitated by other favourable circumstances (e.g. artificial drainage).

Apart from the marked permeability of sand and gravel, the idea of considering barren sand dunes was further influenced by the established fact that the main danger from sodium ions in irrigation water grows with the amount of colloidal clay particles in the soil, since these ions are adsorbed by the latter and make the soil impermeable to water by deflocculation. The sands of shifting dunes are obviously particularly poor in such clay particles and provided the best basis for our experiment.

In addition to these physical facts, certain phyto-physiological phenomena were also considered. Halophytic and drought resistant plants show a similarity in that, quite generally, both are assumed to need a relatively high environmental osmotic value. Another important fact taken into consideration was the slowing-down of water intake by the roots with higher concentrations. The influence of temperature and other climatic factors on all physiological processes played another and often decisive role.

For these reasons dunes and gravel soils gave the best prospects for experiments with certain plants to be grown and irrigated with water of high salt concentration. Economic aspects of the species chosen were also taken into account, and priority was given to species of higher economic value.

One of the first steps in this direction was the hydro-engineering experiment of A. Werber(27) on light agricultural soil without plants but with irrigation water of 800 mg/l Chlorine content, then thought to be of exceptionally high salinity (1936). In recent years a few cautious experiments were even made with diluted seawater.

Prof. E.R. Purvis (New Jersey), described his experiment in a letter to Prof. H. Heimann. During the dry summer 1954/55 he irrigated crops on a fertile soil with a dilution of oceanic

water (14,000 mg total salt content in four applications of 1 inch each, at weekly intervals, in addition to normal crop treatment, irrigation and rainfall) and found no practical damaging.

Experiments of a similar nature but on a bigger scale are being systematically worked out at the U.S. Salinity Laboratory in California(Correspondence of December 1958 with Director H.F. Hayward. See also ref. no. 23 a and 23 b). It is to be hoped that the details of all these important experiments will be published in the near future so that they can be combined with the results of our experiment to assist further progress.

More research is being carried out on Desalination (Demineralisation). An extensive review of the Advisory Committee on Arid Zone Research of UNESCO (24) "On Saline Water Conversion" reveals that 85 scientific Institutes are working on this subject. A short review and survey of the various methods of desalination is also to be found in an article by W.G.V. Balchin (1) in "The New Scientist".

4. THE DESERT GARDEN OF ELATH

Before we began to experiment with seawater and dune sand, we took the opportunity to make preliminary investigations (E. Boyko, 2,3).

In summer 1949 one of us (E.B.) was entrusted with the task of planning a desert garden at Elath, the southernmost point of Israel in the Negev on the Red Sea. The climate there is that of absolute desert, with less than 25 mm annual rainfall and its sparse vegetation is confined to Wadis and to the "Sabha", i.e. depressions near the very saline groundwater. These depressions have a more or less heavy soil, whereas the surrounding hills are built of gravel rock débris, and are completely devoid of vegetation.

We did not choose the depressions, the "Sabha", for planting, in spite of the temptation offered by the many halophytic bushes (of Suaeda fruticoa, Tamarix spp., of date palms, etc.)growing there already, but we chose the bare hills on account of their high permeability. This can be seen from their physical soil structure in Table I:

Table I. DESERT GARDEN OF ELATH: Mechanical soil analysis

Stones (Granite and Limestone)	61.0 %
Coarse Sand	23.0 %
Fine Sand	12.3 %
Silt	2.7 %
Clay	1.0 %
	100.0 %

Elath is situated in one of the hottest and driest areas of the world. The mean monthly temperature of July is about 33° C., of January 15° C.,(mean yearly relative humidity is 39,1 %, with strong and persistent winds, mainly from the north, less frequently from the south). Day temperature in the shade frequently reaches 43° C., but the nights are mostly cool.

The great success achieved there with saline water of a fluctuating salt content of about 2000-6000 mg/litre (mainly sulphates) can be seen from the two pictures: Fig.1 and 2, showing the start of our experiment and Fig. 3, showing the same area nine years later. Today it is a splendid public garden in an absolute desert region, and it represents a most valuable recreation centre for the desert harbour town of Elath. It has been irrigated continuously with water containing up to 6000 mg/litre total salt content.

THE EXPERIMENT WITH SEAWATER: Encouraged by this success, we tried to obtain financial support for our main idea in order to experiment with much higher extremes on a bigger scale and under more exactly controlled conditions (Investigation of percolation and salt-accumulation by exact instrumentation (lysimeters, etc.), of solution intake by plants with isotopes, using as many species and varying treatments as possible). After years of unrewarding applications for the necessary support, we began to experiment without any specific budget. For this reason the investigation was simplified to the very minimum and involved personal sacrifices both of time and of money.

We used empty asphalt barrels, we cleaned them and made holes in the bottom, thus achieving quick percolation. The barrels were filled with sand from the dunes near Bat Yam, South of Tel Aviv: its composition can be seen from Table IV. We refrained from painting the dark barrels in order to save expense, but we measured the temperatures in the rootlayer 2 cm apart from the fringe on all sides and in the centre at a depth of 7 cm. There were well defined differences in the daily temperature curves, but no differences could be observed in the development of the plants in consequence of this factor. Another arrangement of plants and another scale of experi-

ment would have been necessary to achieve a statistical basis for such conclusions.

In order to imitate a certain dune height and a similar percolation we stood the 90 cm high barrels upright, after making many small holes of about 1 sq. cm in their bottoms. Later we took out the entire bottoms and put the barrels into furrows filled with sand, thus achieving a depth for percolation of 1.30 m. This enlarged by far the potential number of species to be experimented with. With these simple and cheap methods all species with a root system of about 1 meter or less (most of the cereals for instance, and many others) could be investigated.

In order to overcome to a certain degree the restriction in the choice of plant species, we chose two with very different natural habitats: the first (Agropyrum junceum Beauv.), a highly xerophytic pioneer of the lightest soils, the shifting sand dunes; and the other (Juncus arabicus Asch. et Buch.), a swamp plant and halophyte, known from the salty swamps on very heavy alluvial soils. We collected the seed material of Juncus from the Oasis Jotvata ("Ein Ghadian") in Wadi Araba and that of Agropyrum from the coastal dunes near Haifa.

This wide ecological range enables conclusions reached to be applied to a great number of other species, in the first instance to all xerophytes and to all species with a certain degree of salt tolerance. Our experience in Elath and the soil analyses made during this experiment with seawater show, however, that the potential range of species may be still wider. This is so, particularly for experiments with brackish waters, which frequently occur in desert regions with dune areas or with soils of a similar good permeability (e.g. some hammadas, gravelly hills, old Wadi beds, etc.).

Both species were also chosen from the point of view of their potential economic aspect.

Juncus arabicus is a valuable cellulose plant which has been shown to be excellent for making high quality writing and printing paper.

Agropyrum junceum is a fodderplant of high nutritive value (see Table V). In addition, this grass is closely related to wheat, and successful cross-fertilizations have often been made (N. I. Vavilov, 25). Hybrids between Triticum and Agropyrum junceum have also been found in nature. (J. Rousseau, 21).

This indicates that, once genetical work has begun, there may be good prospects for achieving a perennial, drought resistant and salt tolerant cereal for arid areas under saline irrigation. The number of chromosomes in our Mediterranean Ecotype of Agropyrum Junceum is 28, the same as in many wheat varieties (C.D. Darlington and E.K.J. Ammal, 12).

The length of the dry season during which seawater or brackish water can be used without damaging plants is decisive for certain species, since it is necessary to utilize the hot season for the development of most plants. In order not to risk a too lengthy dry season, but still to use that part of the hot season necessary for its development, we started the experiment with Juncus at the end of July 1957; that is, about two to four months before the end of the dry season. Thereafter it was expected that effective rains would wash away any accumulation of salt in the root layer (Compare Fig. 4).

Our main aim at this stage of the experiment was not to follow the specific development of particular plant species, but to discover what plants could exist at all in view of the small accumulation of salt expected.

The actual accumulation, following regular drenching with highly concentrated seawater solutions, was to be ascertained by soil- analyses after a specific period, and we wanted this to be influenced by root layers from the very start.

Agropyrum was sown on the 9th of February 1958, in a manner similar to that in a densely sown wheat-field. This date was chosen because we observed that, in its natural habitat on shifting dunes germination occurred during the rainy season approximately at that time.

The three dry months (see fig. 4) which we utilized in summer and autumn 1957 already indicate a possible application for many other less resistant species in large parts of the Mediterranean and other coastal areas of the globe.

Most areas of coastal dune however have a short season of complete drought. A much smaller proportion including Israel, experience a long dry period. The same relation applies approximately also for inland regions.

Rainfall distribution in coastal areas can be seen from the map (Fig. 5) and from Table II.

Table II. APPROXIMATE SEASONAL DISTRIBUTION OF RAINFALL (PRECIPITATION) IN COASTAL REGIONS (Expressed as a proportion of the total coastal length)

Coastal lines in	with a dry season of about 3 months or less approximately	with a dry season of more than 3 months approximately
Australia	1/2	1/2
Africa	1/2	1/2
Asia	3/5	2/5
America	4/5	1/5
Europe	6/7	1/7
All Continents except Antarctica	2/3	1/3
Coastal lines except the Arctic	5/8	3/8

Although providing a rough estimate only, the map and the table show that approximately two thirds of all coast lines have no dry season at all, or one of less then three completely dry months. Even if we exclude the Arctic coast lines as irrelevant, we still find 5/8 of the remainder with these more humid conditions. The results of the first three months of our experiment apply, therefore, to about two thirds of all coastal areas with highly permeable soils and to extensive inland regions. The second dry period of our experiment is about 9 months and, even if the number of species may be restricted by this, the principle may be applied to almost all arid regions as well as to other areas.

For logical reasons the coast line of the Antarctic continent and for technical reasons those of most of the islands and inland lakes are not taken into this rough account, although many of them (e.g. Lake Tsad, Lake Aral) are situated in arid regions with dune areas. On the other hand, in more humid places the need for saline water does not yet exist. If, however, we read articles such as that by C.J. Jackson (18) about the surprising rise of water use near great cities, then we see that this problem is not without significance even in humid regions (Areas of soils other than dunes, with high permeability, may also reach considerable dimensions and can be computed from the soil maps of each region).

The total area of coastal dunes cannot be estimated here. The total of all dune-areas is officially stated as 3,200 millions of acres; that is twice as much as the total area and seven times as much as the agricultural area of the United States of America. (Ch.Y. Whitfield and R. L. Brown, 28).

5. WATER- AND SOIL - ANALYSES

It may be remarked here that the total salt and NaCl concentration in the seawater along the coast of Israel is higher than that of many parts of the ocean. The following data illustrate this:

The specific weight of oceanic waters varies from approximately 1.023 to 1.031 according to the salt content. Near the coast this content may differ, mainly as a result of evaporation, precipitation and the influence of rivers. The average total salt content of oceanic water, according to G. Grillot (23a) is 35%.

The following figures give a rough idea of average seawater composition (see also E.D.Howe, 23c, for comparison).

NaCl	26,900 mg/litre
$MgCl_2$	3,200 " "
Na_2So_4	2,200 " "
$CaSo_4$	1,400 " "
KCl	600 " "
Various	100 " "
	34,400 mg/litre

Some other examples are: The total salt content of oceanic water taken near Point Pleasant, New Jersey is 28,000 mg/litre according to a letter from Prof. E.R. Purvis, New Jersey.

The North Sea near the dunes of Holland has approximately 17,500 mg/litre and near Denmark even

less. The Caspian Sea has a total salt content of about 13,000 mg/litre, decreasing from South to North (The Karabuga Bay with its extremely high salt concentration is almost completely disconnected from the Caspian Sea itself). The Aral Sea has about 10,000 mg/litre, the Baltic Sea only 6000 mg/litre total salt content.

The salt content in the Mediterranean Sea is much higher and increases from West to East. Its average total is about 37,000 mg/litre, that of the eastern parts near Crete 39,900 with a NaCl content of about 30,000 mg/litre. The NaCl content of the seawater actually used in these experiments is about 31,700 mg/litre, and the total salt content 43,600 mg/litre.

According to theoretical consideration and to our observation in nature we expected that, after several months' irrigation with seawater, a small salt-accumulation, particularly of NaCl not used by the plants and not washed down, would be found in the root layer. This would be eliminated from time to time by fresh water irrigation, or by the winter rains. The results of the analyses, however, exceeded our expectations. The figures of barrels 4 to 5a, show that even after 1½ years of the experiment and after a daily irrigation with 100% seawater during the dry season, there was no accumulation of salt whatsoever. The highest concentration of NaCl in the dry soil of the root layer, i.e. in barrel 5a, was necessarily much smaller (minimum 6160, maximum 10,480 mg NaCl/litre) than the amount added by the last single irrigation the preceding day (31,700 mg NaCl/litre). In this case, however, we still had a moisture content of 14.7% – 15.0% in the soil sample at the time of its analysis.

Four analyses of the seawater used, taken always from the same spot on the coast, gave almost identical results:

Table IIIA. SEAWATER-ANALYSES *)

Seawater from the Mediterranean Sea near Bat Yam, South of Tel-Aviv (Jaffa). The water from this spot was used in our experiment during the entire period (July 1957 up to date, 31. December 1958). Date of analysis: 7. August 1958.

Total Salt Content:		43,600 mg/litre	
Analysis			
	Na^+	: 12,500 mg/litre	or meq (= milliequivalent)
	K^+	: 455 " "	
	Ca^{++}	: 725 " "	
	Mg^{++}	: 1,230 " "	
	SO_4^{--}	: 3,118 " "	
	Cl^-	: 22,750 " "	
		40,778 mg/litre	
Calculated amounts:	$CaSO_4$	2,965 " "	or meq
	$MgSO_4$	1,713 " "	
	MgCl	3,530 " "	
	KCl	870 " "	
	NaCl	31,700 " "	
	Various	2,822 " "	
		43,600 mg/litre	

Table IIIB. DILUTIONS USED IN THIS EXPERIMENT

Barrels	Dilution	Total salt-content	NaCl	comparable to:
1 1 a	Tapwater from the Citrus-grove at Beth Dagon			normal drinking-water
2 2 a	25 % Seawater 75 % Tapwater	1,1 %	0.8%	Aral Sea (1%) Caspian Sea (1.3%) >Baltic Sea (0.6%) >most brackish desert waters
3 3 a	50 % Seawater 50 % Tapwater	2.2 %	1.6%	North Sea (1.7%)
4 4 a	75 % Seawater 25 % Tapwater	3.3 %	2.4%	Oceanic concentration
5 5 a	100% Seawater	4.4 %	3.2%	East-Mediterranean Sea

*) The analyses were made at our request in the Chemical Laboratory of the Ministry of Agriculture, Agricultural Research Station, Rehovot.

These figures can be compared with the average salt content in the saline waters of oceanic and other origin mentioned previously.

Even the concentration of 75% seawater used successfully in the barrels No.4 and 4a of our experiment was, therefore, similar or higher than that of pure seawater in many parts of the ocean and much higher than that of many salty seas, salt lakes and other brackish waters; e.g. the North Sea, the Caspian Sea, the Baltic Sea, etc., and far higher than that of most of the underground-waters in deserts and other regions.

There are species which are able to absorb a part of the salt content of saline irrigation water. Others are not able to do this. Accumulation can be foreseen especially in experiments with the latter group of species in less permeable basins, beneath inland dunes, and in coastal regions where there is insufficient rainfall and/or no outlet for the underground-water to the Sea.

Geological research and regional hydrological and pilot hydro-engineering experiments must be combined in such cases with ecological investigation. Premature conclusions without such specific and regional experiments must be avoided.

But, after proving that accumulation in the root layer is not to be feared - the main research must now be aimed at achieving the most nutritive solution for each species. Pure sea-water in various concentrations was intentionally used in this first experiment. It should not be overlooked, in this connection, that seawater has been the medium for plant and animal life through most of geological time and that all essential trace substances are probably contained in it.

These facts, together with possibility of occasionally using partially fresh water for direct irrigation or combined with many other varied treatments, enlarges considerably the potential number of species and the applicability of the principle in general. When we have cheap energy at our disposal to divert seawater to inland dunes, then the prospects will appear very great indeed. In any case, even if this first experiment had been less satisfactory, it would have justified the recommendation of experiments along these lines in all countries with sand-dunes, gravelly or similar soils.

The most important consequence of the absence of any accumulation in the soil is that the decisive limiting factor for the growth of any plant species with salt water irrigation on dunes and similar soils, depends upon their specific ability successfully to use water of that chemical composition and specific concentration. The danger of accumulation which is the factor prohibiting the growing of field crops irrigated with even slightly brackish water on normal agricultural soils was completely prevented by the principles devised here.

According to existing formulae (as, for example, that quoted by G. Grillot, 23a) and the empirical experience, greater amounts of irrigation water must be used with higher concentrations; but we did not rely on formulae for the reason that with such unusually high concentrations the existing empiric formulae may be misleading.

For practical use the energy problem will in any case be an important factor. But, these problems and their solutions must be tackled by technicians after the results of theoretical research and adequate scientific experiments have paved the way.

The complete lack of accumulation in our experiments can be seen from Table IIIC, which indicates the results of soil-analyses after about a year's irrigation with various dilutions of seawater up to approximate oceanic concentration (75%) and to the still higher concentration of East Mediterranean Seawater (100%).

Table IIIC. SOIL-ANALYSES
Total Salt and NaCl content in the soil (dune sand) after irrigation with various seawater concentrations.
Beginning of irrigation: 31 July 1957.
Date of Analysis : 2 July 1957 (based on dry weight 105° C.)

Barrel No.	Daily irrigation (see Fig. 2.) with:	Depth of soil samples	Moisture %	Cl %	Calculated NaCl % (Coeff. 1.6)	Total sum of salts %
1	0 % SEA-WATER (Tap- water)	10 cm	6,7	0.004	0,0064	0.017
		30 cm	0.5	0.003	0.0048	0.015
		60 cm	1.0	0.004	0.0064	0.015
1		10 cm	6.8	0.013	0.0208	0.032
		30 cm	1.5	0.004	0.0064	0.015
		60 cm	1.0	0.004	0.0064	0.013
2	25 % SEA-WATER NaCl 0.793% Total 1.090%	10 cm	4,6	0.050	0.0800	0.100
		30 cm	4.3	0.061	0.0976	0.120
		60 cm	2.2	0.044	0.0704	0.090
2		10 cm	8.1	0.056	0.0896	0.115
		30 cm	3.8	0.061	0.0976	0.120
		60 cm	1.9	0.046	0.0736	0.095
3	50 % SEA-WATER NaCl 1.585% Total 2.180%	10 cm	1.8	0.097	0.1552	0.190
		30 cm	2.2	0.083	0.1328	0.180
		60 cm	1.5	0.058	0.0928	0.120
3		10 cm	5.8	0.115	0.1840	0.235
		30 cm	4.6	0.098	0.1568	0.190
		60 cm	3.3	0.110	0.1760	0.210
4	75 % SEA-WATER NaCl 2.378% Total 3.270%	10 cm	1.8	0.138	0.2208	0.280
		30 cm	1.8	0.115	0.1840	0.235
		60 cm	2.4	0.075	0.1200	0.145
4		10 cm	5.0	0.160	0.2560	0.300
		30 cm	2.4	0.107	0.1712	0.220
		60 cm	2.9	0.080	0.1280	0.255
5	100% SEA-WATER NaCl 3.170% Total 4.360%	10 cm	11.9*	0.358	0.5728	0.675
		30 cm	14.1	0.463	0.7408	0.950
		60 cm	15.9	0.460	0.7360	0.900
5		10 cm	10.6	0.510	0.8160	0.950
		30 cm	13.2	0.465	0.7440	0.900
		60 cm	15.3	0.540	0.8640	0.950

* The high moisture content of these six analyses of barrel 5 indicates a still lower salt content, if the samples were taken a few hours later and with the same low moisture content than those of the other barrels. The control barrels gave similar results.

6. EXPERIMENTAL DATA OF PLANT DEVELOPMENT

As mentioned above, cleaned asphalt barrels formerly used for road building were stood uprignt and adapted to allow percolation. Sand was taken from the dunes of Bat Yam in its natural composition in order to imitate natural conditions as far as possible. Table IV shows the composition of this dune sand.

Table IV. MECHANICAL SAND ANALYSIS

Physical soil-structure analysis in %					Total % of $CaCO_3$	Water Solution 1:5		% Organic Matter	pH
>1.0 mm	1.0 -0.50 mm	0.50-0.25 mm	0.25-0.10 mm	<0.10 mm		Total Soluble Salts	Cl		
0.0	1.0	15.0	78.8	3.5	3.9	0.090	0.044	2.3	8.6

The reasons for choosing Juncus arabicus and Agropyrum junceum as our test plants are given above. Furthermore we had familiarised ourselves with their ecological amplitudes under natural conditions as well as with their potentialities for artificial propagation and cultivation. This was brought about by extensive observations during 30 years in many countries and by experiments over a period of 10 years in Israel (H. Boyko, E. Boyko and D. Tsuriel, 10).

Furthermore both are perennials and live for many decades. Observations on the same individuals can therefore be continued for a very long time, thus excluding unknown specific factors which might occur in the case of short-living plants which would have to be replaced during the course of long term experiments.

Our method of planting the Juncus seedlings allowed continuous observations on the individual plants, whereas Agropyrum was densely sown and successfully grown in imitation of a field crop.

AGROPYRUM JUNCEUM BEAUV.:

Detailed data of the experiments with individual Agropyrum plants as well as with some other species, will be dealt with in another paper. Figs. 6 and 7 indicate only the general behaviour of Agropyrum junceum. Nevertheless we are publishing these figures here because they demonstrate a practical application of fodder production in sand-dunes with a brackish water supply that may have a high economic value.

The photographs (Fig. 6a and 6b) and the graph (Fig. 7) show the development of Agropyrum in the same barrel. This barrel was irrigated from February 1958 with 11,000 mg/litre total salt content and 7,900 mg/litre NaCl. This corresponds with the concentration of many seas and of highly saline underground water in deserts.

In order to estimate the size of this foddercrop on 18.1.1959 we cut the stalks of 1 sq. dm (10 x 10 cm) at a height of 1 cm above the soil-surface. The yields of this square decimeter (100 square centimeters) weighed 116.80 grams freshweight and 75.62 grams air dry. If calculated to a field area this would be equivalent to the yield of a very rich fodder crop and/or pasture.

From the curve (Fig. 7) it can be seen that growth did not stop throughout the whole year.

The Chemical Laboratory of the Ministry of Agriculture kindly supplied us with the following chemical Analysis of Agropyrum junceum.

Table V. CHEMICAL FODDER ANALYSIS OF AGROPYRUM JUNCEUM

Water	72.6 %
Fats	1.1 %
Cellulose	8.5 %
Protein	4.1 %
Ashes	3.3 %
Carbohydrates	10.4 %
	100.0 %

(Beta Carotin Provitamin A 1.8 mg)

Fieldexperiments under most unfavourable conditions on salty, sandy soils and on sand dunes with and without irrigation have already been carried out successfully in our dune station and in other places, and the plant could now be introduced into the economy of several settlements with great success (D. Tsuriel, 22. See also Ref. nr. 10).

The high nutritive value and palatability, the high yield in spite of most inadequate spacing, lack of fertilizing, etc., and the success achieved with this perennial in the first season permit us to recommend this strain of Agropyrum as a very promising fodderplant on dunes or similar sterile, permeable soils, particularly in latitudes of less than 40°, even in situations where irrigation with highly brackish waters only is available.

OSMOTIC VALUES:

A few remarks should be added here in respect to our measurements of osmotic values both for the dilutions and of the two species.

Osmotic values had to be measured with the strictest precautions and economy of material, as every measurement brought about the destruction of a considerable part of the total material available. We shall therefore draw no conclusions from the results owing to the necessarily small amounts of data.

But, owing to the most interesting figures which they represent, we reproduce here the results of the latest measurements (Table VI).

Table VI. OSMOTIC VALUES (measurements of 10.1.1959)

Dilution		Crioscopic Temp.		Osmotic Value
	Distilled water	- 0.55 °C		
1)	Tap-Water	- 0.6 " "		0.6 Atm.
2) 25 %	Sea-Water	- 1.1 " "		6.63 "
3) 50 %	" "	- 1.55 " "		12.06 "
4) 75 %	" "	- 2.05 " "		18.09 "
5) 100 %	" "	- 2.55 " "		24.12 "
Dilution	**Species**		**No. of barrel**	
1) 0 %	Agropyrum	- 1 °C	1	5.43 "
2) 25 %	"	- 1.14 " "	2	7.12 "
1) 0 %	Juncus	- 0.72 " "	1	2.05 "
2) 25 %	"	- 0.75 " "	2	2.41 "
3) 50 %	"	- 0.91 " "	3	4.34 "
4) 75 %	"	- 0.95 " "	4a	4.824 "

The xerophytic dune plant Agropyrum junceum shows a high osmotic value even when irrigated with freswater and this value rises with higher concentrations.

The hydrophilous-halophyte Juncus, however, shows relatively low osmotic values and seems to withstand the high osmotic pressure and any loss of moisture induced thereby. Exact physiological experiments may bring about results of physiological and physical significance.

Obviously the influence and importance of the osmotic values in plant life need to be thoroughly re-investigated (compare H. Walter, 26, and various textbooks).

JUNCUS ARABICUS ASCH. ET BUCH.:

As for Juncus, 10 seedlings were planted in each barrel and all the seedlings in each barrel were mapped on a simple sketch and measured. Thus, the measurements of all plants could be followed individually and any unforeseen occurrances (dwarfing, dying, abnormal development of any part, etc.) could easily be checked in relation to the whole development and possibly their causes determined.

Fig. 8 shows as an example the sketch of one day's measurements.

Two barrels were equally treated with the same concentration and 10 seedlings were planted on July, 31st, 1957 in each of the eight barrels 1 to 4a. All the seedlings were two months old and had been grown in our own nursery, irrigated with fresh water. They were transplanted at the same age but of two different sizes:

5 plants in each barrel were about the size of 3 - 4 cm and 5 plants in each barrel the size of 7 - 10 cm, the seedlings of both groups having 3 - 4 leaves each (see also Fig.8 and its text).

This was done in order to find out, in this first experimental step, if the taller or the smaller seedlings would be more apt to adapt themselves to high concentrations of seawater.

In the first stages there was ample space in each barrel for each of the ten tiny individual plants. The distance was 15 - 20 cm between the single seedlings. But, later on, when almost all roots and shoots grew surprisingly well there was great root competition, a factor which minimized a possibly greater success.

For 10 days after transplanting the seedlings were watered with tap-water in order to re-root them properly in their new habitat. Nevertheless, a few plants and also a few shoots were lost in the course of this transplantation. Of the 40 larger seedlings transplanted on July 31st, 1957, 3 seedlings or 7.5% were dead on 10. VIII. Of the 40 smaller seedlings transplanted on 31. July, 8 seedlings or 20% were dead on 10.VIII; that is, on the day before we began the seawater irrigation.

It can be assumed that the initial fresh-water irrigation after transplantation could be eliminated and substituted by rains if the time of transplanting coincides with rainfalls, either shortly before or after. In our case, however, (with Juncus arabicus) high temperatures seemed decisively favourable for re-rooting.

After these first 10 days all the barrels received an irrigation of sea-water or seawater-dilution according to the scale of concentrations mentioned before (Table IIIB) and marked in the graphs.

After we had observed that plants lived vigorously even with 75% Seawater irrigation (= 33,000 mg/litre total salt content), we began, at the end of October, to plant Juncus seedlings into barrels using 100% seawater irrigation. But, this time most of the plants died during the transplantation period, in spite of freshwater irrigation. The season seemed unfavourable for beginning this experiment. We continued, however, to irrigate the remaining plants with 100% Seawater. All the plants which survived the transplantation are growing slowly and are developing new shoots up to date but the results are not comparable and are therefore excluded from our conclusions regarding the plants in the other barrels. The only certain conclusion that can be drawn from this part of the experiment is that, even under irrigation with 100% seawater (that is, in this area, 43,600 mg/litre total salt content and 31,700 mg NaCl/litre) all plants that survived transplantation are also surviving this extreme salt concentration with daily irrigation from 1. November 1957 to 31. December 1958.

The further development of the other barrels up to oceanic concentration (barrels 4 and 4a) can be seen from the Figs. 9-11. The first graph (Fig. 4) shows that the first effective rainfall was 13. - 15. November, 1957, but we did not interrupt regular seawater irrigation before the end of November when effective rainfalls occurred over a period of about 8 days. The last effective rainfall occurred on 8. and 26. February, 1958. From then on, seawater irrigation was again the only source of irrigation, apart from a light rain of 0.5 mm on 21. April and of 1 mm on 22. April, 1958, and a momentary sprinkle with tapwater of less than 1 mm on 20. May, 1958, erroneously applied by the gardener.

It was observed with Juncus that if all the seedlings of this species were transplanted at the same age, the growth of smaller seedlings (3-4 cm on 31.July, 1957) was slower than that of taller seedlings (7-10 cm on 31.July 1957). Better results can therefore be expected from taller seedlings (For comparison see also Fig. 8).

The number of shoots (leaves) was the same for all seedlings at the time of their transplanting, namely 3 - 4. Nevertheless, the increase in number of shoots was very variable. It may, therefore, be assumed that the tendency to produce many shoots can be successfully augmented by selection. This maximum number of 196 shoots in barrel 4a, irrigated with water of oceanic salt concentration was less than that of the barrels 1 - 3a, but was the same as that of well-developed plants of the same age raised in a field experiment with manuring, spacing, etc. on heavy soil in Ein Hamifrats. The latter were irrigated with water from the river Naaman, south of Acre, containing about 700 mg/litre chloride only.

The maximum number of shoots developed from single seedlings, all of them bearing 3 - 4 shoots (leaves) at the time of transplantation, can be seen from Table VII.

Table VII. JUNCUS ARABICUS: MAXIMUM NUMBER OF SHOOTS (LEAVES) OF SINGLE INDIVIDUALS

Sea - Water	0%	25%	50%	75%
Barrel No	1 and 1a	2 and 2a	3 and 3a	4 and 4a
Total Salt	(tapwater)	10,900	21,800	32,700
NaCl		7,900 mg/l	15,860 mg/l	23,800 mg/l
Date of measurement:				
10 August 1957	3 - 4	3 - 4	3 - 4	3 - 4
3 November 1957	32	39	16	20
12 January 1958	51	40	34	24
2 March 1958	81	93	42	35
2 April 1958	82	119	53	44
18 May 1958	151	124	94	60
25 August 1958	228	177	167	83
25 September 1958	237	246	205	160
31 December 1958	241	257	227	196

The development from 3-4 leaves (shoots) in each individual to the maximum on 31 December 1958 of 257 shoots in one single individual under irrigation with approx. 11,000 mg/l salt content with 8000 mg NaCl/l was certainly remarkable. But, still more remarkable to us was the development of 196 healthy shoots out of such a tiny seedling under irrigation with approx. 33,000 mg/l total salt content and with approx. 24,000 mg NaCl/l; that is, the 75% dilution of the East-Mediterranean seawater which is equivalent to a concentration of oceanic seawater.

It should be added that the measurements described here were concluded with the end of the year

1958, but that all the plants are continuing to show healthy growth in respect of height and number of shoots. This whole development indicates the possibility of achieving much higher yields by breeding, or even by simple selection.

Its seems reasonable also to expect still better results if seawater irrigation is interrupted by part-time irrigation with freshwater where feasible. This applies to areas where fresh-water resources - either below or above soil surface - are available though not in sufficient amounts to allow a full irrigation; also, wherever fresh-water reserves must be saved or stored - for example, for town-development; or where there is danger of salination of freshwater by over-charging the underground resources. The latter conditions, for instance, occur frequently in coastal areas.

The fact that we purposely chose the worst possible conditions and achieved positive results shows that improvement in yields will be possible. Such improvements, apart from selection, may include optimal spacing, treatment with growth stimulating substances like giberreline acid, and the addition of fertilizers.

We have, however, intentionally refrained in this first experiment from any fertilizing - either with organic manure or chemical fertilizers - and from any other additional treatment, in order to eliminate as much as possible influences other than seawater. We have also refrained from the addition of Potash or Calcium to neutralise sodium-ions in order to simplify this first experiment. The lack of financial resources made it imperative for us to restrict this first experiment to the minimum of barrels and technical work and to adhere exclusively to investigation of the principle, or, more specially, to the combination of the respective physical, geophysical and phytobioclimatological principles.

FOR ALL THESE REASONS, THEREFORE, THIS EXPERIMENT REPRESENTS THE MINIMUM OF SUCCESS *)

In experiments of this kind it may be necessary for economic reasons to know the time-retarding effect of higher salt concentrations on plant growth. This may be of less importance in the case of long living plants such as Juncus arabicus or Agropyrum junceum, for example, but, even with these, it may change the optimal times and/or frequency of harvesting, or the time of the first harvest in general.

In our experiment with Juncus this time-retarding effect on minimum height and maximum number of shoots can vaguely be seen in Table VIII. We say "vaguely" because the small size of this experiment indicates only the trend of development, and does not give the desirable statistical basis.

Equally, we have not as yet touched upon the question of the optimal irrigation- quantities with the respective dilutions. We used 5 litres per barrel for each irrigation because with this amount we were certain that water would percolate to and through the bottom of the barrel. We intend to decrease this amount gradually, in order to discover the optimum amount for each species with regard to its various development stages.

It was also clear to us from the beginning that the time of percolation was an important factor for each species, but we did not intend to include different and controlled permeabilities for the reasons mentioned above. It is therefore only by chance that we can now observe the considerable effect of this factor, if only in a general way, particularly in the barrels with higher concentrations, i.e. in barrels 3, 3a, 4, 4a (see Table IX).

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*) After this paper was written we received a manuscript from Professor H.Heimann ("Irrigation with saline water and the balance of the ionic environment"), in which are discussed the possibilities of creating balanced composition in the solution. His studies open up further ways for application of our principles. In spite of this, we would not go so far as to say that experiments on demineralisation should be stopped but research work on the utilisation of oceanic water should be approached from both sides.
The economical one explained here, as well as the costly experiments on demineralisation should be continued. Our method may lead to success with many species, but with others success may be achieved only if combined with desalination. In this case even desalination could prove to be of economic value, particularly if combined with the methods of counter-balancing the sodium ions, described in the paper of H.Heimann (16) mentioned above.

Table VIII. TIMETABLE OF GROWTH

TIMETABLE OF MAXIMUM NUMBER OF SHOOTS 1)
Period 31.7.1957 till 31.12.1958

Number of shoots:	4	40	60	80	100	120	150	200	240
Achieved with:	on	on	on	on	on	on	on	on	on
0% seawater (tapwater)	31.7.57	1.12.57	27.1.58	25.2.58	24.4.58	28.4.58	17.5.58	22.7.58	6.12.58
25% seawater	"	12. 1.58	31.1.58	17.2.58	12.5.58	17.4.58	5.7.58	5.9.58	20. 9.58
50% "	"	17. 2.58	10.4.58	4.5.58	25.5.58	22.6.58	1.8.58	20.9.58	not yet
75% "	"	22. 3.58	18.5.58	31.7.58	30.8.58	6.9.58	18.9.58	not yet (10.1.59)	not yet

1) Compare Fig. 10.

TIMETABLE OF MAXIMUM HEIGHT 2)
Period 31.7.57 till 31.12.1958

Max.Height of leaves 3)	10 cm	20 cm	30 cm	40 cm	50 cm	60 cm	90 cm	100 cm
Achieved with:	on	on	on	on	on	on	on	on
0% seawater (tapwater)	31.7.57	1.9.57	17.10.57	13.12.57	12. 4.58	2. 5.58	1.10.58	30.12.58
25% seawater	"	1.9.57	17.10.57	15. 2.58	21. 4.58	20. 5.58	2.12.58	not yet
50% "	"	24.9.57	not yet	5. 4.58	8. 5.58	15.11.58	not yet	not yet
75% "	"	15.9.57	20.10.57	higher leaves broken by birds and not comparable			? (see Fig. 9)	?

2) Compare Fig. 9
3) Flowering stems not included (they are much higher)

Table IX. GROWTH DIFFERENCES CAUSED BY DIFFERENT PERMEABILITY

Measurement of 18 May 1958	Irrigation with 50% seawater		Irrigation with 75% seawater	
Barrel No.	3	3a	4a	4
Percolation	slower	quicker	slower	quicker
Average height in cm (of the 4 highest individuals in each barrel on that date)	48.6	33.5	35.4	20.0

We refrained from giving the times of percolation for two reasons. First, we made these measurements with the primitive methods at our disposal, namely by pouring the water in the same measure of time (about 10 seconds) and counting the seconds till the entire surface was again visible. Secondly, conclusions could not be drawn from only two barrels. It should be noted, however, that barrels 3 and 4a always had a slower rate of percolation than the control barrels 3a and 4.

Possible reasons for the different rates of percolation may be chemical or physical or simply that the holes at the bottom varied in size as some of them may have been blocked by a stone or other obstruction. But, with an adequate instrumentation, percolation and the factors affecting it, could easily be controlled in future experiments and the optimal percolation determined.

Part of the explanation of this difference in growth may also be physiological (slower intake with higher concentration). In other words, the rootsystems in the more slowly percolating water may somehow take in the saltwater better and evaluate its meagre nutritient matter, than root systems in the too-quickly percolating water. Irrespective of any additional nutrition given, manure would most probably reduce too rapid percolation. This could, however, also be achieved by other methods, such as by plowing in seaweed, by regulating nutritient solutions, or by increasing the amount of irrigation. These problems are of secondary importance in this initial experiment, but it is worthwhile remembering them in forthcoming experiments with Juncus or any other species.

The 90 cm high asphalt-barrels had a diameter of 46 cm ($r^2\pi = 1662$ cm^2). The sand-surface was therefore equivalent to about 1/6 m^2 and irrigation with 5 litre was equivalent quantitatively to 30 mm of rain. The exact amount of sand varied with the barrel and was between 1/7 to 1/6,5 m^3, the volume of the root layer about 1/12 - 1/10 m^3. The sand-surface was kept about 5 cm below the fringe of the barrel; not higher, in order to enable higher rainfalls to percolate and as in nature. They were not kept lower, in order to avoid too much shadow, creating adverse conditions.

The barrels were placed more than 7 m from a white wall, 4 m high, in order to prevent influence by reflex radiation (H. Boyko, 8).

Certain irregularities in the growth rate of the plants in the various barrels, particularly in the development of new shoots, led us to raise the question of whether the cooler months, or quite generally lower temperatures, may not be more favourable for plantgrowth under highly saline than under freshwater irrigation. It may be a general law, or a specific problem for each species. Only the teamwork of bioclimatological, physiological, and bio-chemical research can give the answer. It is possible, for instance, that certain chemical processes connected with growth-retarding may be intensified by higher temperatures. These lines of research, however, transgress the limits of our experiments and of our abilities *).

We hope to continue this work, but in any case the results encourage similar experiments elsewhere. New lines of research in other countries too may result in a rise in the production of potential food and industrial plant raw materials far beyond present expectation.

7. CONCLUSIONS AND SUMMARY

It can be concluded in general, that the experiment described above has proved the soundness of the theory on which it was based.

If highly permeable soils extend deeper than the root layers of the plant species growing in them, then no accumulation of salt is to be feared, even if oceanic water is used for irrigation. Accumulation of salt in the deeper layers of these soils is washed away into even deeper depressions in the desert or into the sea by irrigation, rainfall, or the flow of underground water.

Highly saline water in deserts and sea-water can be used for the cultivation of a number of economic plants if used, not on the usual agricultural soils but ON SAND-DUNES OR SIMILAR SOILS WITH HIGH PERMEABILITY.

In consequence of these basic results the experiment justifies the undertaking of further extensive research. The main lines indicated by these results, include experiments as follows:

1) Appertaining to problems of minimal, maximal, and optimal amounts of sea- and saltwater of varied quality, varied mixing, alternating with freshwater, varied timing, control of percolation, aeration, accumulation in correlation with the varied climatic and meteorological factors.

2) With numerous prospective species of economic value, with priority for halophytes (salt tolerant plants) and xerophytes (drought resistant plants), under various climatic conditions and under varied treatment in many countries, in coastal regions as well as under continental conditions.

3) Bioclimatic, agronomic, agrotechnical and hydrotechnical experiments must be undertaken after the basic ecological results have been achieved with the species or ecotypes to be investigated.

4) Genetic experiments (selection, crossing, etc.) to achieve luxuriant plant material of ever increasing salt- and drought-tolerance and shockresistance.

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*) With great pleasure we express out thanks to the devoted collaboration of our coworkers in this experiment, to Mr. Arnold Douwes, Chief Gardener, who did the technical work of irrigation and recorded the rainfall on the spot, to Miss Ilse Herzberg, who made the drawings and to Mrs. Adiva Ilan, who carried out the measurements of osmotic values and is now starting experiments with giberellinic acid as growth-stimulants. We owe also particular thanks to the Meteorological Service of the Government for supplying us with a raingauge and with the data of daily Maxima and Minima of temperatures.

5) Finally, economic investigation and fieldexperiments on a large scale must be undertaken in order to transfer the results into the economic sphere.

As a result of such experiments, we see good prospects for putting into production enormous stretches of dune lands and other desert areas irrigated with practically limitless amounts of available highly saline water, of many seas up to oceanic concentration and brackish underground waters in all areas, but particularly in arid and semi-arid regions.

The ultimate development will also depend on the development of cheap energy of any kind, particularly of atomic energy and of sun-radiation, for these natural resources are at our disposal in just as limitless quantities as are the waters of the ocean.

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Fig. 1: Organizing the planting of the desertgarden in Eilat by Dr. Elisabeth Boyko in November 1949. (Note the artificial reservoir above). All the plants to be seen are either already planted or prepared for planting. Water was brought by Command-car in barrels from Ber Orah, 18 km North of Eilat.

Fig. 2: First planting on the vegetationless gravel. Details of "methods" and of "soil" show the technical difficulties

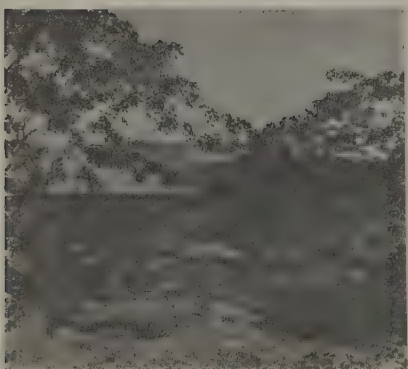


Fig. 3: Views of the same Desert Garden at Elath in 1958. (For comparison with Fig. 1 and 2, taken 9 years earlier)

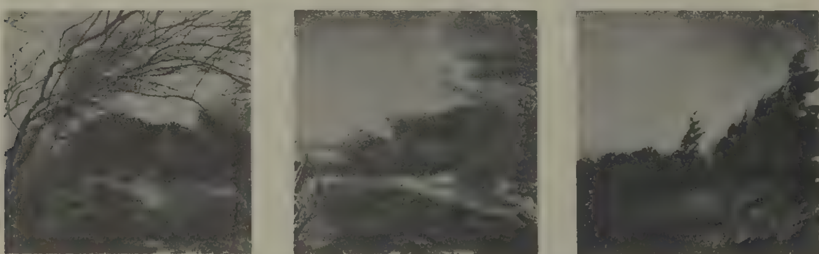


Fig. 4
H. and E. Boyko
Sea-water Irrigation, Rainfall and Temperatures

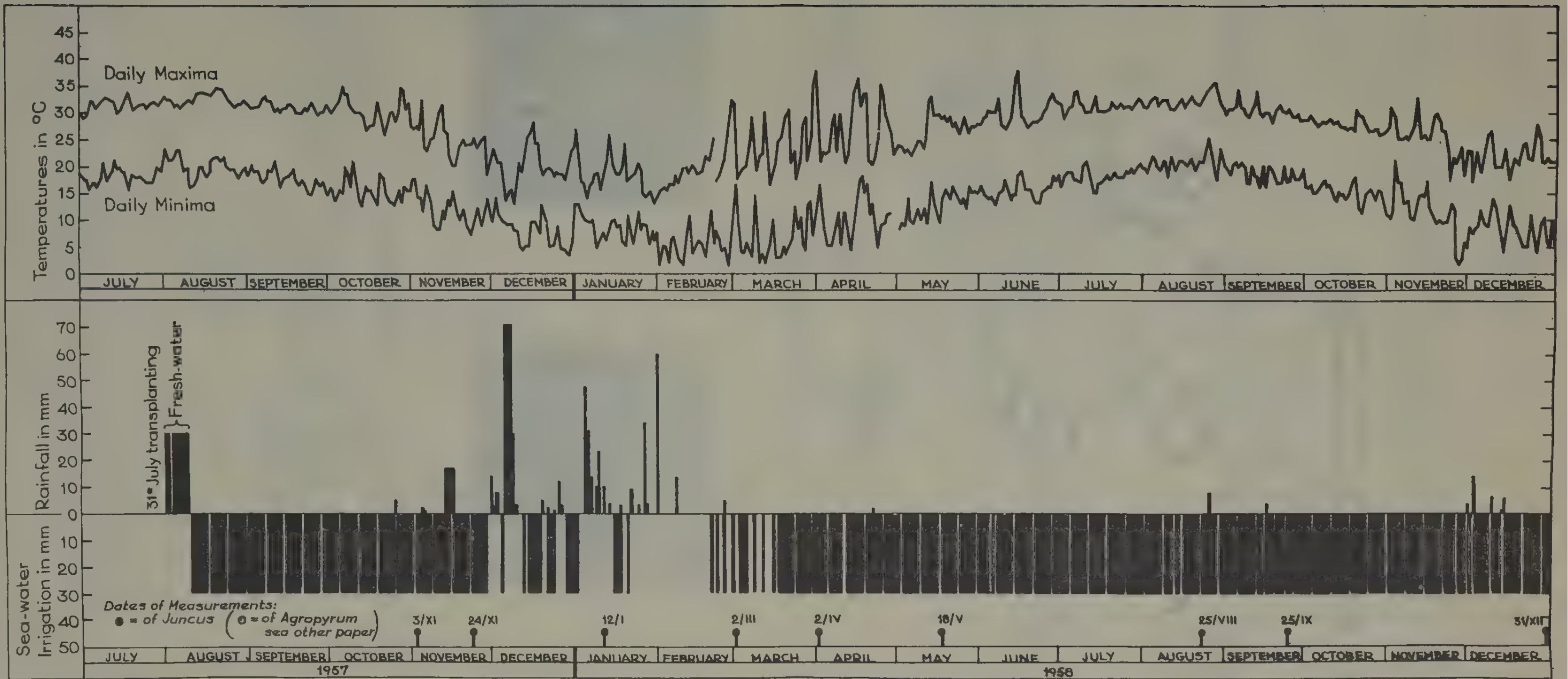


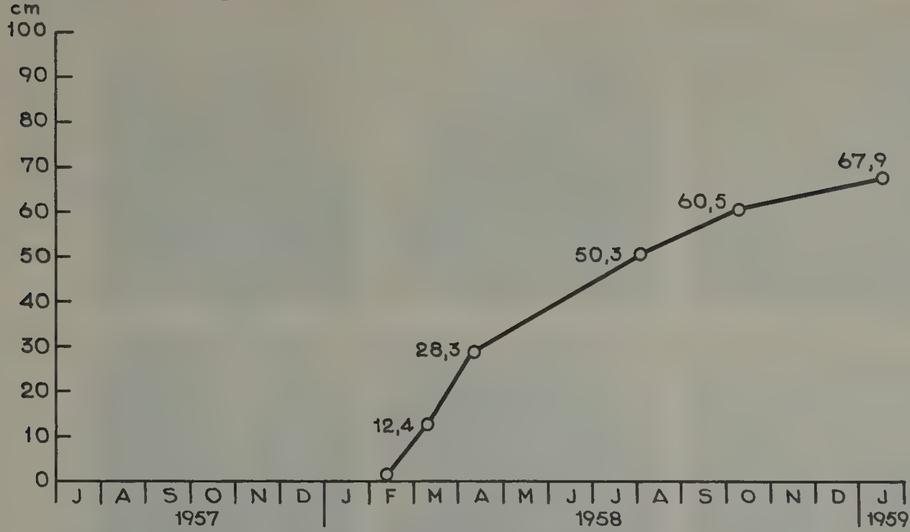
Fig 5
Distribution of Dry Periods in Coastal Areas

a b

Fig. 6: SEAWATER IRRIGATION OF AGROPYRUM (Barrel No. 2)
(Agropyrum junceum sown on 9 Febr.1958) a) left 20.May, 1958
b) right 20.Dec.,1958
The left half of the plants on photo 6b were cut for measurements of osmotic value. The plants were irrigated from 15.February, 1958 with 25% dilution of seawater, i.e. with water of 11,000 mg/l total salt content and 8,000 mg/l NaCl.

Fig.7

Sea-water-Irrigation (of Agropyrum junceum)



Average Maximum of the 10 highest non fruiting stalks (Barrel No. 2)

Irrigation water { 11,000 mg/liter total
8,000 mg/liter Na Cl

Fig. 8

An Example of the Method of Measurement

Barrel No 1a (0%) on 2 March 1958

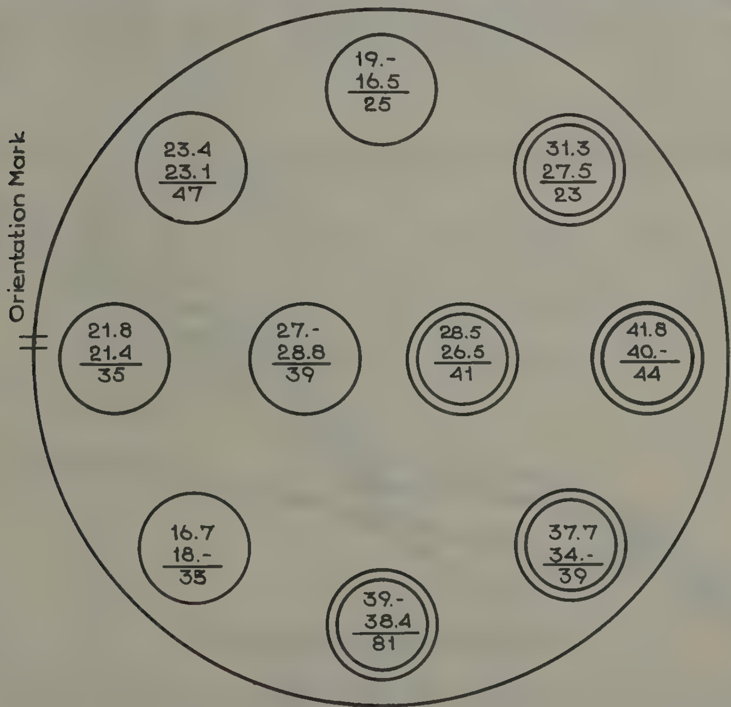


FIG. 8 gives an example of how the measurements were done. The two figures above the line indicate the height of the two highest leaves in this individual, the figure below the line indicates the number of green shoots on this day.
A single circle is the sign of an individual grown from a small seedling (3 - 4 cm on 31 July 1957); A double circle indicates an individual grown from a tall seedling (7-10 cm on 31 July 1957).

Fig.9

Sea-water-Irrigation. (Maximum Number of Shoots of Juncus arabicus)

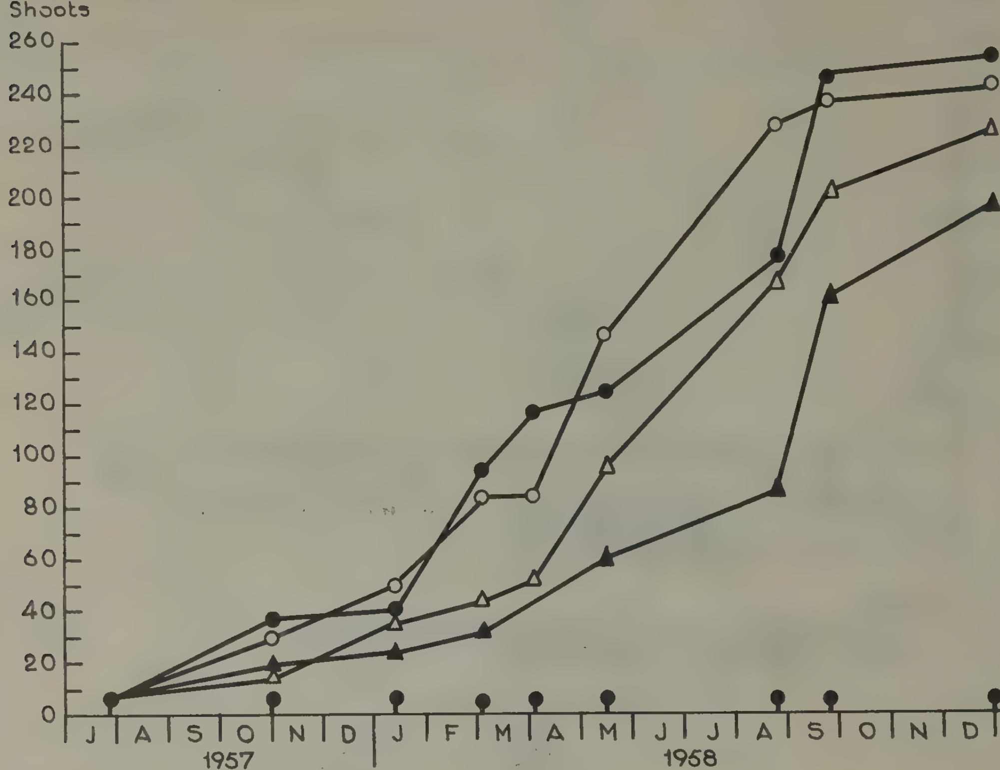
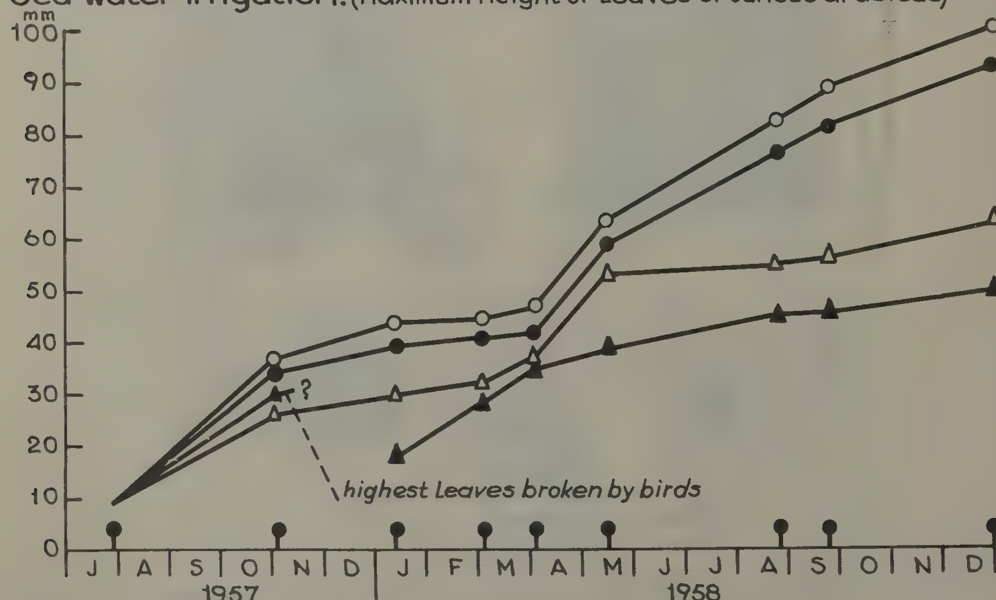


Fig.10

Sea-water-Irrigation. (Maximum Height of Leaves of Juncus arabicus)



Irrigated with

▲ – 33,000 mg/liter total Saltcontent with 24,000 mg/liter NaCl
△ – 22,000 mg/liter total Saltcontent with 16,000 mg/liter NaCl
● – 11,000 mg/liter total Saltcontent with 8,000 mg/liter NaCl
○ – Freshwater (tapwater from Pardess Beth Dagon)

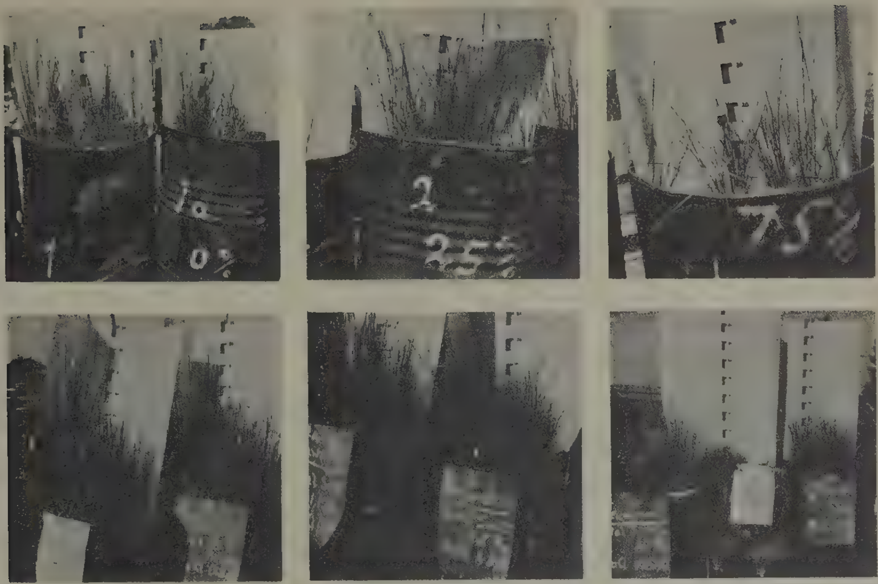


Fig. 11: SEAWATER IRRIGATION OF JUNCUS ARABICUS

Comparison of the plants above with those below shows the development of Juncus arabicus. Of the 4 barrels above (photos taken on 20. May 1958). 3 are to be seen below (photos taken on 25. Sept. 1958).

No. 1a (second from the left above, first below)
Irrigated with fresh-water

No. 2a (middle photo above, second from the left on the first photo below)
Irrigation with 25% seawater (11,000 mg/l total salt content, 8,000 mg/l NaCl)

No. 3 (is not te be seen above, but shows below its healthy development)
Irrigation with 50% seawater (22,000 mg/l total salt content, 16,000 mg/l NaCl)

No. 4 The plants were cut in order to measure their osmotic value.
Irrigation with 75% seawater (33,000 mg/l total salt content, 24,000 mg/l NaCl).

No. 4a (first from the right above and below). The photo below is taken from a greater distance, but shows clearly the healthy development of the plants.
Irrigation with 75% seawater (33,000 mg/l total salt content, 24,000 mg/l NaCl).

P H Y T O L O G I C A L   B I O C L I M A T O L O G Y

Section B1: General agricultural bioclimatology

SEAWATER IRRIGATION
A NEW LINE OF RESEARCH ON A BIOCLIMATIC PLANT- SOIL COMPLEX

by

Dr. Hugo and Elisabeth Boyko (Israel)

A B S T R A C T

Over a period of many years the authors have frequently observed the occurrance of non-halophytic plant species growing in islands in the midst of halophytic plant communities. Closer investigation has shown that these islands usually appear in places with high soil-permeability, or with good drainage.

In 1949, on the occasion of laying out and planting a desert-garden in Elath, on the Red Sea, this general principle was tested and used in a practical manner.

A garden was laid out and successfully irrigated with water of 2000-6000 mg/l (mainly sulphates) on completely barren slopes of broken rock débris with soil of good permeability. About 180 plant species, many of them of economic value, were introduced into this extreme desert area which has less than 25 mm average yearly rainfall. The garden is used today, as the town's recreation centre and the plants provide the basis for planting in several new settlements in the Wadi Araba.

On the basis of these results an experiment was started under extreme conditions in order to show that no accumulation takes place in the root layer in well-drained soil, even if irrigated regularly with very saline water, provided that the soil is deeper than the rootsystems of the plants grown therein. The experiments consisted of planting two species having extremely different ecological ranges on dune sand. One of the plants, Agropyrum junceum Beauv., is a xerophyte of shifting dunes - that is of the lightest soils. The other, Juncus arabicus Asch. et Buch., is a halophyte from salt swamps, and the heaviest soils. The economic value of the first lies in its high nutritive value and palatability as fodder; that of Juncus in its excellent qualities for papermaking (writing and printing paper).

The plants were irrigated with controlled amounts of various dilutions of East - Mediterranean seawater containing 43,600 mg/litre total salts and 31,600 mg/litre NaCl.

All soil-tests showed that even after 100 applications of seawater of the highest salt concentration (43,600 mg/litre total salt content), no accumulation occurred in the soil-layers at 10 cm, 30 cm and 60 cm depth.

These results therefore indicate that there are great possibilities for growing many plants of economic value with different ecological amplitudes, on sands and soils of similar permeability under irrigation with the large amounts of brackish waters available in deserts and, in the case of certain more salt tolerant species, with seawater. It is advocated that similar experiments should be tried out in other countries in order to coordinate and to develop their far reaching aspects.

Section C : Forest bioclimatology

Section D : Physiological phyto-bioclimatology

Section E : Pathological phyto-bioclimatology

PHYTOLOGICAL BIOCLIMATOLOGY

Section E: Pathological phyto-bioclimatology

METEOROLOGY AND THE TIMING OF FUNGICIDE APPLICATIONS AGAINST POTATO BLIGHT

by

P.M. Austin Bourke (Eire) *)

1. INTRODUCTION

There has been a striking growth of interest in meteorology as applied to the control of plant disease since 1920, and particularly in the last ten years or so. This has, in large part, been due to the careful attention now being given to the economics of plant protection techniques and to a growing realisation that meteorological advice can contribute largely to bringing down the costs of protective measures, and at the same time increasing the efficiency of control of the disease.

Everyone is familiar with examples of the direct effect of weather on the host plant and on the life-cycles of fungus and insect pests. But even when there is no clear-cut environmental influence on the disease itself, meteorological factors may still play a decisive role through their effect on the population level and activity of vector insects. Thus in England in 1957, the mild preceding winter and dry spring were most favourable to the aphid which spreads the disease of sugar beet called virus yellows and as a result the crop suffered the worst outbreak since sugar beet became a principal crop in England.

In other cases, the connection between weather factors and a plant disease are even more complex. Bruzone disease of rice, for example, is caused by hydrogen sulphide developing in the soil. Weather affects the development of the disease in two ways (Reference 10). Firstly the gas is released from sulphides, reduced from sulphates, by the action of acids developing from the decomposition of organic matter. In the case of a prolonged winter and a cool spring, the decay of organic matter is hindered and the disease is correspondingly held in check. Secondly, the transport of the gas by irrigation water increases with cooler weather at the end of Summer because of the increase in the gas-absorbing capacity of the water with falling temperatures; hence the disease appears generally with decreasing temperatures at the end of Summer.

2. POTATO BLIGHT AND WEATHER

Amongst the plant diseases of major economic importance, potato blight (Phytophthora infestans) is undoubtedly the one whose appearance and spread is most completely under the direct control of environmental factors. In analysing the seasonal progress of other plant diseases, e.g. apple scab (Venturia inaequalis), weather data must be supplemented by observations on the initial level of inoculum, and on its ripening and dispersal. In most potato growing countries, however, the fungus responsible for potato blight is almost invariably present to a degree sufficient to give rise to an epidemic if only suitable weather occurs and persists. Again, contrary to what happens with many other crops, the host plants are susceptible to the disease at all stages of their development, so that no phenological observations, other than a knowledge that the plants are above ground, are required to supplement weather data. Finally, weather effects on the growth of the potato plant itself play no major role in blight epidemiology; it is permissable to concentrate entirely on environmental influences on the propagation and spread of the fungus.

In summary, then, weather data are a necessary and sufficient basis for forecasting the onset and spread of potato blight, provided the favourable conditions for the multiplication of the fungus can be defined.

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3. DEFINITION OF "BLIGHT WEATHER"

The first necessary step, then, towards a practical Weather Warning Service against potato blight is to reach a SATISFACTORY DEFINITION IN TERMS OF ORDINARY METEOROLOGICAL OBSERVATIONS of the weather conditions favourable to the progress of the disease. A fair measure of success has been obtained in this objective (Reference 4).

Empirical rules were first developed in England and Holland. At the same time, laboratory experiments in the U.S.A. and elsewhere showed the necessity for a period of at least ten to twelve hours of saturated air within the crop cover, at temperatures of the order of 10° to 15° C, for the formation of blight spores. They also established that the spell of high humidity required to be followed immediately by a period of several hours during which free moisture was present on the foliage of the host plant in order to permit germination of the spores and reinfection of the host. These laboratory results were made the basis of definitions of "blight-weather" developed in the U.S.A., Germany, Holland and Ireland.

The author's system is used in the Blight Weather Warning Service which has been operated with success by the Irish Meteorological Service since 1952 (Ref. 1,2,3,6). It has also proved applicable in Chile (reference 5) and in Tasmania (Reference 11).

4. THE UTILITY OF FORECASTS OF POTATO BLIGHT

The possibility of identifying "blight-weather" had little practical value before the present century, when the practice of the regular spraying of the potato crops with copper or other fungicides was introduced in areas such as Ireland where the disease makes a regular appearance each year. The use of fungicides against potato blight does not eradicate the disease; its effect, rather, is to retard its spread by killing the spores which emerge during favourable weather, and thus, by lengthening the period of growth of green parts of the plant, to ensure a better crop of tubers. It soon became obvious that the timing of the applications of fungicide was all-important both from the point of view of effectiveness and economy. A spray applied after the disease had already taken a firm hold on the crop was too late to exercise any effective control on the subsequent damage. On the other hand, too early spraying lost most of its value because, by the time the disease was moved to activity by favourable weather, much of the protective layer of fungicide had been washed off the foliage and because there had been a substantial growth of new and unprotected leaves. Experience gradually dictated a fairly effective routine viz. first application of fungicide as soon as the earliest spots of the disease appeared in the crop, followed by other sprayings at fairly short intervals to protect the growing foliage.

However, the impact of disease varies very greatly from year to year with weather conditions, and it was clear that it should be possible to develop a more rational and elastic spraying programme based on meteorological information. Such a programme would indicate not only the best date for the initial spraying, but would also take into account the later probabilities of spread of the disease, enabling the number of fungicide applications to be restricted in years unfavourable to the epidemic development of blight and thus saving a substantial amount of money for the farmer.

5. MERE IDENTIFICATION OF "BLIGHT WEATHER" INADEQUATE

It was mentioned, in paragraph 3 above, that adequate rules for the identification of weather favourable to potato blight have been developed in several countries.

However, the satisfactory definition of "blight weather" in quantitative terms still leaves other problems to be solved before it can be applied to the epidemiology of the disease and in particular to the efficient timing of fungicide applications. It cannot be too strongly stressed that the simple use of identified blight weather periods for timing of anti-blight sprays has serious drawbacks, as illustrated schematically in Figure 1. In the three sub-diagrams X represents the date of initial visible appearance of blight in the crop, and XYZ the blight progress curve based on percentage of foliage diseased, using the valuable concept introduced by the English plant pathology school (Reference 9). P_1 and P_2 represent, respectively, periods of weather leading to the first sign of the disease and to significant subsequent progress. In several countries not operating a weather-warning system, a spraying advice (A) is issued to growers immediately following the visible appearance of the disease in the general crop. The possibility of identifying the favourable weather period, P_1, as it occurs, enables the farmer to be warned (W) of the imminent appearance of the disease some time before it becomes visible on the foliage. This anticipation can be of considerable value if, as in subdiagram A, the next favourable weather period (P_2) follows in quick succession, since it will often give the farmer the extra

notice necessary to permit him to take protective measures before P_2 commences.

However the reverse applies in the case illustrated in sub-diagram B where a lengthy period elapses between periods P_1 and P_2. Here, with the disease lying dormant for several weeks, spraying even at time A may be too early because of the effects of weathering and growth of new unprotected foliage before the next active period occurs. Spraying at the still earlier date W is even more premature in this case. Clearly for efficient spraying routine it is necessary that the identification of P_1 should be supplemented by means of foreseeing whether or not further favourable periods are likely to occur in the immediate future. Indeed, the ideal situation would be to issue a forecast warning (F.W. in subdiagram C) before the first of a series of favourable weather periods had begun.

6. A BASIS FOR FORECASTING "BLIGHT WEATHER"

Already it is possible, at least in some areas and in some years, to make reliable forecasts of the probable occurrence of weather favourable to potato blight, using the synoptic approach to plant disease forecasting. This involves relating the occurrence of blight-weather periods to the type of meteorological situation on synoptic weather maps which gives rise to them (Reference 6)

As regards NW Europe, the types of synoptic situation which are significant for blight epidemiology are comparatively few and easily identified. Two of the most important blight-fomenting situations in this area are:-

(1) OPEN WAVES OF MARITIME TROPICAL AIR: The weather which accompanies this airmass, as it arrives over North-west Europe during the potato-growing season, is normally ideal for the development of potato blight, viz. overcast skies with rain or drizzle, saturated or near saturated air and temperatures of the order of 12-16°C.

(2) STAGNANT OR SLOW-MOVING DEPRESSIONS GIVING LENGTHY PERIODS OF WET OVERCAST WEATHER: Ill-defined quasi-stationary fronts are frequently associated with this type of situation and widespread outbreaks of thunderstorms are not uncommon, particularly in the later stages.

One of the basic advantages of the synoptic approach is that it provides a sound basis for forecasting the probable trend of future weather as related to plant disease and thus overcoming the disadvantages discussed in connection with Figure 1. It also enables us to link potato blight epidemiology with the main body of research work on synoptic meteorology and long-term forecasting, and to take advantage of such concepts as "steering" (which gives a clue as to the probable track of future depressions) and "blocking" (which may check blight by shutting off the supply of maritime Tropical air for a considerable period).

It is true, of course, that despite the progress made, weather forecasting for more than a short period ahead is still fraught with difficulties. However some of the problems which beset general forecasting, e.g. the accurate timing of changes, do not apply in the case of plant disease epidemiology. In the latter case, it is sufficient to know that certain weather types are likely to predominate in the immediate future, irrespective of the exact dates on which they will occur. For this reason it is already possible on occasions to issue a "forecast warning" for potato blight purposes covering a period well in excess of that for which a detailed forecast could prudently be made.

7. SYNOPTIC BLIGHT FORECASTING IN PRACTICE

A few of the turning points in the 1958 blight forecasting system in Ireland may illustrate how the synoptic approach is applied in practice.

Early June showed abnormally high rainfall in most parts of Ireland. From June 13th to 18th, however, was generally dry, but it would have been premature to advise spraying unless it could confidently be said that the weather would soon revert to moist, warm conditions.

Figure 2 shows the surface weather chart of June 17th. A broad south-westerly current of maritime Tropical air covered much of the Western Atlantic, and it was clear that, although the anticyclonic ridge would give fine spraying weather for another day or two, an influx of warm moist air into Ireland was inevitable, and was likely to persist, or recur with short interruptions, probably to the end of the month.

Accordingly the first spraying warning for Ireland was broadcast on June 17th. The area which it was expected would be affected by the first wave of maritime Tropical air is illustrated in Figure 3(a), and what actually developed in Figure 3(b), in which the figures denote the effective duration of blight-weather at each observing station (Ref. 1,2,3,6). This synoptic weather system moved on into continental Europe, as did the immediately following depressions, including

a remarkably deep low on June 25th–26th. The period June 21st–30th gave rise to blight weather generally in potato-growing Europe, as far East as Poland.

Blight made a general appearance in Ireland at the end of June and beginning of July. The first spray warning was particularly well timed, in that it enabled the growers to take advantage of practically the only suitable spraying weather which occurred during the month.

A short lull in Ireland early in July enabled a second warning to be issued on July 7th, after which the weather reverted to conditions markedly favourable to the disease. Figure 4 illustrates the synoptic situation at the surface on July 21st. A ridge of high pressure moving in from the Atlantic promised better conditions for the first time in the 1958 Summer – but how long would they last? A glance at the marked East-West trough on the upper air chart (Figure 5), on which the analysis was confirmed by the upper wind reports shown, supplied a confident answer – barely long enough to enable spraying to be repeated before the bad weather systems appearing on the left of Figure 4 would again bring recurrent bad weather to Ireland.

Accordingly the third spraying warning, in the form of a general alarm issued by newspaper and radio, was circulated on July 21st. It stressed that the 1958 blight attack in Ireland was expected to be the worst for many years. By early August, this gloomy view was only too clearly justified, and poorly sprayed crops were destroyed in many areas by mid-August. In some parts of Ireland, the blight attack of 1958 was the worst during the present century.

8. THE FUTURE

The application of meteorology to the control of potato blight has made considerable progress in recent years. The synoptic approach, described above, has the merit of providing a possible means of considering simultaneously a whole group of plant diseases with similar general requirements for humidity, moisture and temperature. For example, Byrde (Reference 8) in a study of Brown Rot of Apple (Sclerotinia fructigena) has found that the weather conditions leading to outbreaks of sporulation in England were generally associated with either a slow-moving shallow low-pressure system or a moist south-westerly airstream of tropical or sub-tropical origin i.e. similar conditions to those favourable to the spread of potato-blight.

Progress in the case of other diseases is making rapid strides; a particularly promising feature is the application of upper air charts to problems of the dispersion of spores of cereal rusts and similar infections (Reference 7). In the case of soil borne diseases, the meteorologist is so far hampered by the limited observations available of soil temperatures and soil moisture.

The Commission for Agricultural Meteorology of the World Meteorological Organisation is alive to the importance of studies of meteorology as affecting the epidemiology of plant diseases. Apart from the report on potato blight already published (Reference 4), a Working Group to prepare a similar study on Apple Scab has recently been established.

In the general picture, the most important limiting factor is probably our still imperfect quantitative knowledge of the environmental factors of importance in the development of many plant diseases. As this is overcome, and with ever closer co-operation between plant pathologists and meteorologists there is a bright future for weather-disease studies, not only as applied to epidemiology, but also in the broader field of general plant pathology problems where meteorology can contribute to saving time and money by suggesting a rational approach in place of hit-or-miss empiricism.

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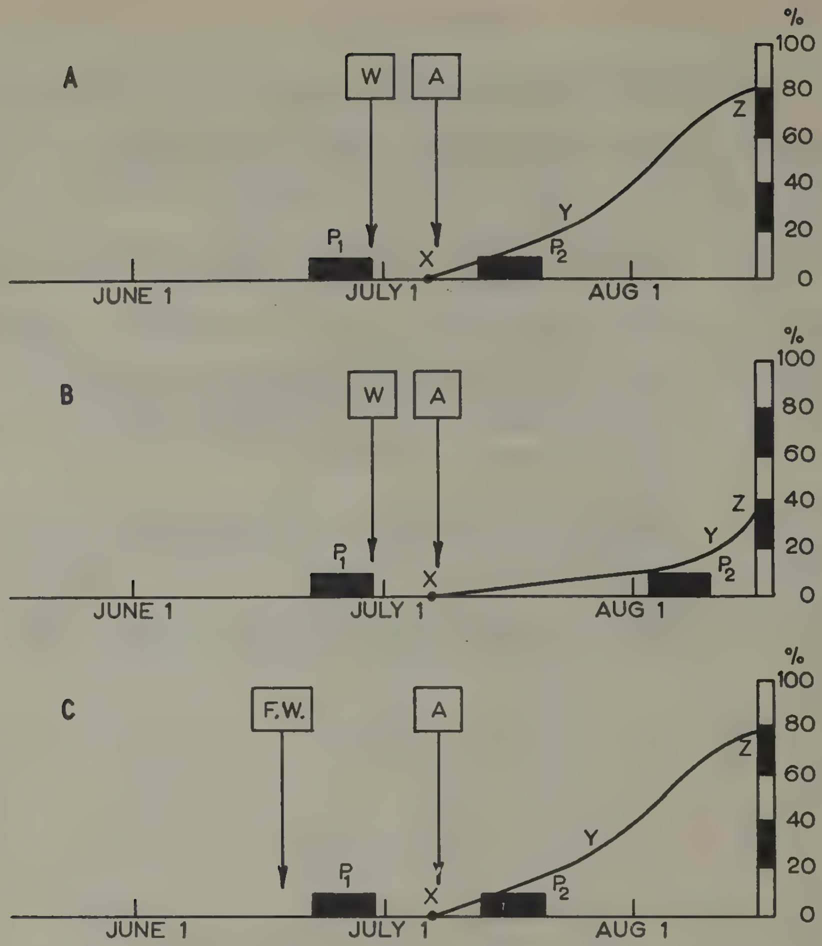


FIG. 1: RELATIONSHIP OF DIFFERENT CATEGORIES OF ADVICE AND WARNING ON THE DATE OF FIRST SPRAYING AGAINST POTATO BLIGHT.

P_1 = Period of blight-weather leading to first visible signs of disease.

P_2 = Subsequent period of blight-weather leading to intensification of disease.

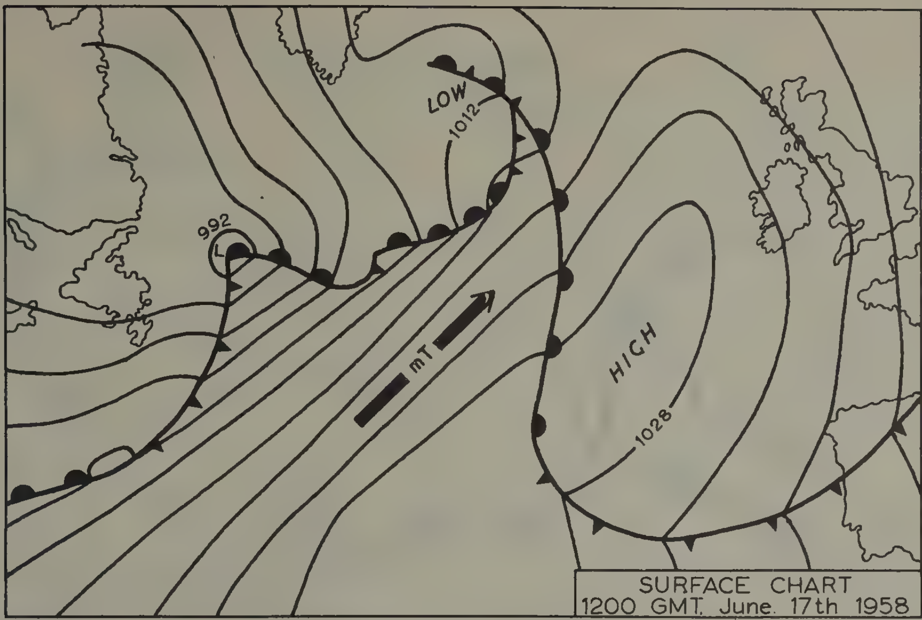
X = Date of first visible signs of disease.

XYZ = Blight progress curve based on percentage of foliage attacked, as shown by vertical scale on the right.

A = Date of spraying advice based on first visible appearance of disease.

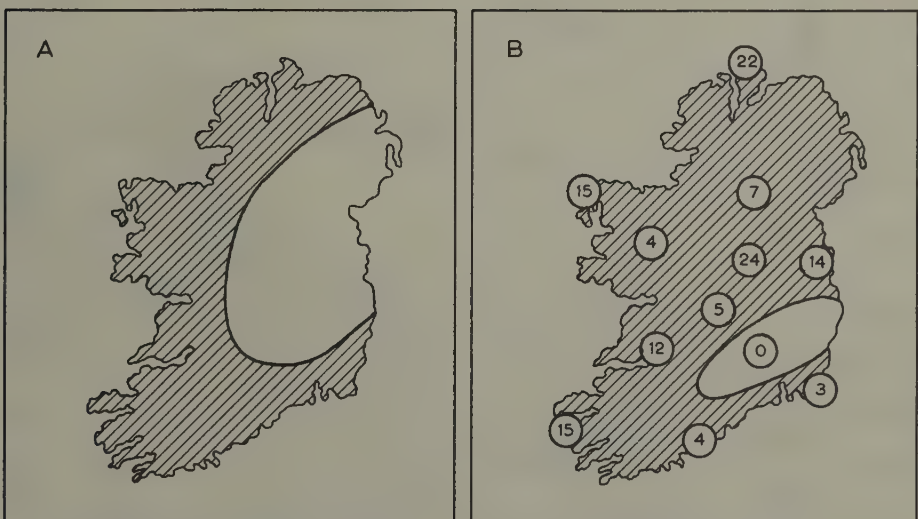
W = Date of spraying warning based on <u>occurrence</u> of significant period of blight-weather.

FW = Date of forecast spraying warning based on <u>expectation</u> of significant periods of blight-weather.



LOW
1012
992
L
mT
HIGH
1028
SURFACE CHART
1200 GMT. June. 17th 1958

Fig. 2



A
EXPECTED NEXT BLIGHT - WEATHER
JUNE 19 - 23 (APPROX) 1958
B
22
15
7
4
24
14
5
0
12
3
15
4
ACTUAL BLIGHT - WEATHER
JUNE 19 - 21 1958

Fig. 3

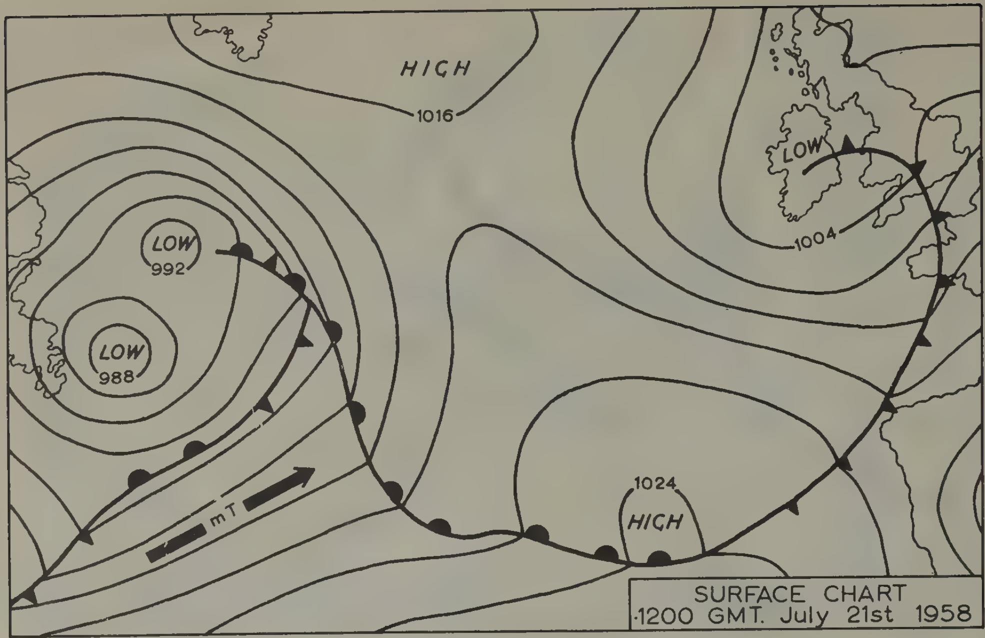

HIGH
1016
LOW
LOW
992
LOW
988
1004
mT
1024
HIGH
SURFACE CHART
1200 GMT. July 21st 1958

Fig. 4

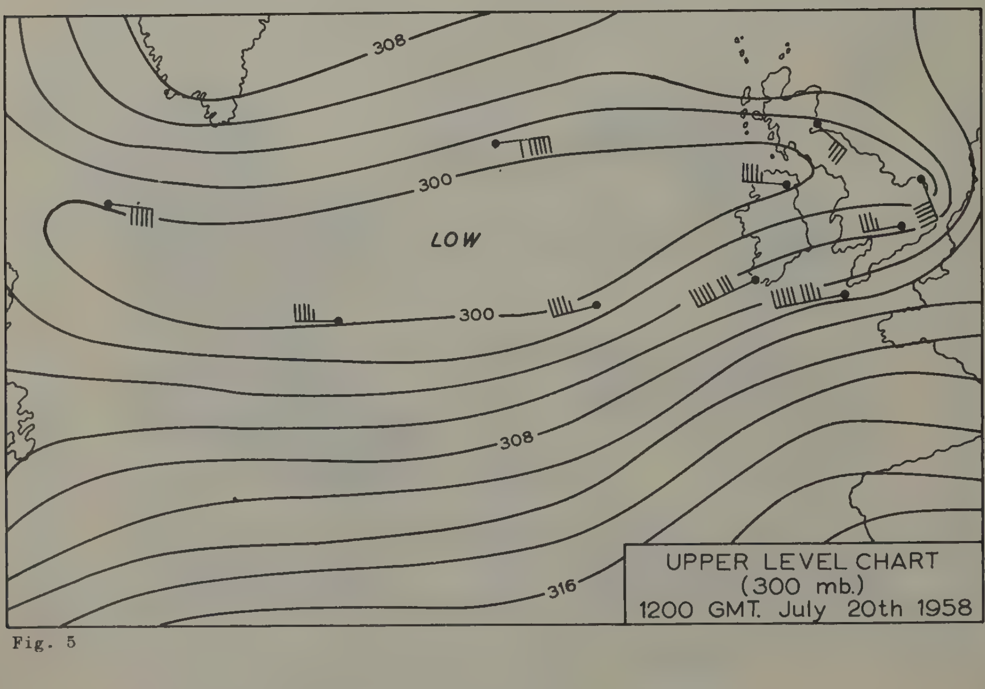

308
300
LOW
300
308
316
UPPER LEVEL CHART
(300 mb.)
1200 GMT. July 20th 1958

Fig. 5

Section F : World literature

PHYTOLOGICAL BIOCLIMATOLOGY

Section F: World literature *

GENERAL PHYTOLOGICAL BIOCLIMATOLOGY

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PART III

ZOOLOGICAL BIOCLIMATOLOGY

(1959)

Section A : General Zoological bioclimatology

Section B : Entomological bioclimatology

ZOOLOGICAL BIOCLIMATOLOGY
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MICROCLIMATE, DIURNAL RHYTHMS AND THE CONQUEST OF THE LAND BY ARTHROPODS.

by

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I. INTRODUCTION.

The conquest of the land by insects and other arthropods illustrates a number of fundamental points of behaviour in the responses of the animals to the simple stimuli provided by the bioclimatological conditions of their physical environment.

The distribution of animals is determined not only by a number of geological factors and by the physical conditions of the environment - light, temperature, moisture, wind, acidity or alkalinity and so on - but also by its biotic factors which include plants and other animals. In the present review, however, I shall be concerned only with interpreting the distribution of terrestrial arthropods in terms of their psychiological responses and behavioural reactions to the former. The significance of these at once becomes apparent when one remembers that most of the oldest fossils found in geological strata are marine and the sea is a relatively stable environment, not subjected to violent changes in temperature, salinity, etc. In this medium were evolved all the major groups of animals and during succeeding epochs most of them managed to conquer the land to a greater or lesser extent.

Life on land entails a number of problems: larger animals require structural support; respiratory organs must become adapted for breathing air and there is no surrounding water into which toxic excretory compounds can diffuse. Small animals have a very large surface area in proportion to their mass; consequently the conservation of water and the maintenance of a fairly constant internal medium are especially important. Many terrestrial invertebrates such as insects, spiders and mites avoid becoming desiccated by the development of a thin layer of wax which is relatively impervious to water vapour. Of course, such a layer is also impervious to oxygen and carbon dioxide: a respiratory mechanism has therefore had to be evolved which permits gaseous exchange to take place whilst restricting water-loss to a minimum. The spiracles of insects and the lung books of spiders and other arachnids are normally kept closed by means of special muscles, and only when carbon dioxide in the body begins to accumulate are they opened to facilitate respiration. It can easily be shown experimentally by weighing that the rate of water-loss by evaporation from an insect or arachnid is greatly increased when 5 per cent carbon dioxide is present in the atmosphere, as this results in the respiratory apertures remaining fully open. Before moulting takes place a new wax layer is secreted beneath the old cuticle that is due to be cast off, so that the ecdysis is effected with a minimum loss of water (39, 43, etc.).

In addition to such morphological and psysiological adaptations to life on land, insects and arachnids have evolved special excretory products - uric acid and guanine respectively - which are extremely insoluble. Consequently nitrogenous waste matter can be eliminated from the body in a dry state and no water is lost in the process.

Another method of avoiding desiccation on dry land is found in woodlice, centipedes, millipedes, springtails and many other small animals which remain most, if not all of the daytime in a damp or humid environment under stones, fallen leaves, and in crevices under the bark of trees.

The terrestrial arthropods can, therefore, be roughly divided on an ecological basis into two main groups. The first includes woodlice, centipedes, millipedes and their allies which, in dry air lose water rapidly by transpiration through their integuments (8, 23, 24, etc., 34). Consequently they are restricted by reflex behaviour mechanisms to damp, dark habitats which they leave only at night when the temperature falls and the relative humidity of the atmosphere increases (18, 19, 20, 22, 23, 25, 27, etc.).

The second group includes most insects and arachnids; these are comparatively independent of moist surroundings because their integument possesses an impervious layer of wax which prevents desiccation (13, 14, 15, 16, 20, 30, etc.).

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Each aspect of adaptation to life on land affects, and is affected by other aspects. For example, if the integument is rigid and provides support, then growth becomes impossible except by moulting and this limits size. Size is also limited where the respiratory system consists of tracheae and tracheoles. The physiology of nutrition and excretion are closely concerned with water conservation. Superimposed upon such basic morphological and physiological requirements are the numerous concomitants of behaviour and ecology, for orientation and behaviour mechanisms must also be evolved to retain organisms in environments to which they are suited, to find food, mate and, indeed, carry out the functions essential to their continued existence.

II. WOODLICE AND THE LAND HABITAT

Woodlice show a diurnal rhythm of activity and tend to wander abroad during the night, when the temperature drops and the humidity of the atmosphere increases. This rhythm is correlated with alternating light and darkness and not with fluctuating temperature and humidity although these factors of the environment are probably of greater importance in their daily lives (11). When taken into the open, they are stimulated by light and drought so that they run actively until, by chance, they reach some dark damp spot where they come to rest. They can run directly away from light, but one searches in vain to find any directed orientation towards moist air or damp surfaces. The animals run aimlessly, turning first one way then the other. But, as the air becomes damper, their speed decreases (36,42).

This behaviour can be illustrated by a simple analogy with motor cars. Suppose a procession of cars is travelling at a steady speed of 50 m.p.h. outside a town. On entering the restricted zone the speed falls to 20 m.p.h. which is retained through the urban area. Now it will be seen that the cars are closer together. If the front vehicle is halted at traffic lights, an aggregation will occur which disappears when the cars speed up again in the open country. The time interval between the passage of one car and the next will be the same throughout the town and the country but, because they move more slowly in the built-up area, they will automatically be closer together. So it is with woodlice which move more slowly and consequently aggregate in damper air.

In addition to this simple ORTHOKINESIS or variation in linear velocity, woodlice tend to turn more and more frequently as they pass through a zone of moist air, until they finally come to rest. This is a KLINOKINESIS similar to that found in PARAMOECIUM CAUDATUM which aggregates in regions of slight acidity. It is by such purely mechanical reactions that woodlice aggregate under bark and stones. Experiments have shown that the animals are not in any way attracted towards one another. They merely gather in the same place as a result of behaviour reactions which drive them away from light and from dry places (35, 42).

By means of choice-chamber apparatus it has been found that the intensity of the humidity response of the woodlice is less in darkness than in light and still less in the nocturnal phase; it increases with desiccation. Movement away from light is more marked in animals which have been in darkness for some time, and is still initially shown in dry air whereas control animals move towards the light when humidity is sufficiently reduced. Finally, the active phase is correlated with increased sensitivity to external conditions such as the carbon dioxide content of the air.

These experimental results can be related to the nocturnal ecology of the species. Woodlice are often to be seen wandering in dry places at night: as we have seen, they spend the daytime under stones, logs and in other damp, dark situations where environmental conditions are relatively constant. If nightfall involved only a reduction of the factors which normally operate to restrict them to their daytime habitats, it seems unlikely that they would have any occasion to leave them. The endogenous diurnal rhythm or physiological "clock", however, will engender locomotory activity in some individuals at least at nightfall when they are especially sensitive and easily disturbed. Even if the majority are exposed to daylight only occasionally, this may be sufficient to maintain their periodicity and keep it in phase with the 24-hour cycle (11).

Field observations on P. SCABER have indicated a shortening in the time of activity as the days lengthen to midsummer and also a lack of any clear relationship between activity and changes in temperature or relative humidity (2).

The decrease in the intensity of the humidity response at night enables woodlice to walk in dry places where they are never to be found during the day, and the increased photo- negative response after they have been conditioned to darkness ensures that they get under cover promptly at daybreak and thus avoid many potential predators. On the other hand, if their daytime habitat should dry up, the woodlice are not restrained there until they die of desiccation since they tend to become photopositive in dry air and thus are able to wander in the light until they find some other damp hiding place and again become photo-negative (11).

Even the desert woodlouse, HEMILEPISTUS REAUMURI, has a 24-hour periodicity and water relations essentially similar to those of woodlice from temperate regions. Although this species can withstand hot, dry conditions for some considerable time there is no "critical temperature" to indicate the presence of a cuticular layer of water-proofing wax (24).

The rate of water-loss by transpiration in a number of British species of woodlouse has been investigated by Edney (32,33,34). They have been shown to stand in the following order; PHILOSCIA MUSCORUM > ONISCUS ASELLUS > PORCELLIO SCABER > ARMADILLIDIUM VULGARE.

At temperatures just above freezing the intensities of the reaction to humidity of all species are much reduced and do not differ significantly from one another. At higher temperatures (30° C) the humidity responses of PH.MUSCORUM and O. ASELLUS are again somewhat reduced, and it is suggested that this may be associated with a lower thermal death point and the need to effect a reduction in body temperature by evaporation (25).

The humidity responses of woodlice are shown to be correlated with saturation deficiency rather than with relative humidity. No specific sense organs are concerned with the appreciation of humidity and the response is probably engendered as a result of desiccation. It may result from the influence of increased concentration of the body fluids stimulating proprioceptors (42).

All species must spend the greater part of their time in an atmosphere that is saturated with water vapour, but there is considerable variation regarding their ability to withstand dry air, high temperatures and in the period of time during which they can venture into dry places.

PH. MUSCORUM is the most strongly photo-negative of the four species and there is a graduation through O. ASELLUS and P. SCABER to A. VULGARE which is the least so. PH. MUSCORUM has been shown by means of aktograph apparatus to be the most intensely nocturnal in habit, A. VULGARE the least. It is therefore suggested that the degree of nocturnal activity may be correlated with the ability to withstand water-loss by transpiration (25).

Finally, it has been shown by measurements with a sensitive anemometer that the nocturnal emergence of woodlice in nature is inhibited by wind. This may well be because air currents tend to remove the shell of moist air that surrounds the transpiring animal (29). The relationship between wind-speed and the number of woodlice wandering abroad at night applies only above a minimum threshold temperature of about 5.5° C, however.

III. THE WATER-RELATIONS OF MILLIPEDES

Somewhat similar responses have been shown to occur in millipedes which also lose water rapidly in dry air. Some species may tend initially to move towards dry places but the reaction is gradually reversed as desiccation proceeds (38). Orientation is again entirely "KINETIC" or non-directional and in an experimental chamber in which a choice of humidities is provided, both the time spent and the distance covered are greater on the moist side.

Millipedes possess a clear endogenous 24-hour periodicity and emerge from the comparatively constant conditions within their daytime retreats under stones, bark logs and fallen leaves, under the stimulus provided by some internal physiological "chronometer".

In the case of the small British millipedes BLANIULUS GUTTULATUS and OXIDUS GRACILIS, an exogenous diurnal rhythm is primarily a response to light and darkness, the degree of nocturnal activity being correlated with the stimulus of falling temperature at dusk (9, 10) and no endogenous activity has been observed. In the large West African species OXYDESMUS PLATYCERCUS and OPHISTREPTUS SP., however, aktograph experiments have demonstrated an endogenous rhythm independent of fluctuating light and temperature and persisting for as long as 19 days in constant light and temperature. Locomotory activity is stimulated both by increases and by decreases of temperature and it is suggested that temperature fluctuations may be of primary importance in the synchronisation of the animals' activities with day and night, for the effect of light on their activity is slight and is perhaps an insignificant factor in their natural gloomy habitat in tropical forests (10).

The response of millipedes to moisture has some economic importance, for under conditions of drought they may be forced to attack growing crops for the sake of water. Thus outbreaks of the "spotted snake-millipede", BLANIULUS GUTTALATUS, tend to be stimulated by a dry spell following a period suitable to the reproduction of the species when the soil is damp, undisturbed and rich in humus. It has been shown experimentally that humus and rotting substances have a texture which is preferred by millipedes to that of living plant tissues, and that the animals are attracted to dilute concentrations of sugars (8).

No doubt a moist season combined with the use of farmyard manure or following some crop producing a considerable amount of humus, will engender a great increase in the number of millipedes in the soil, particularly if the ground is not disturbed by ploughing etc. They can be beneficial at this stage in aiding the breakdown of the humus, but if the following season is dry, even for a short spell, they may be compelled to attack crops for the sake of moisture. Once an attack has been initiated, the attraction of sugars in the plant sap will prevent them from returning to their normal diet of humus and decomposing matter. It is unlikely that damage by millipedes to crops with tough exteriors such as potatoes and mongolds can ever be primary, for not only do their weak mouth parts prevent them from gaining access, but in addition they are not attracted to unbroken skins of potatoes, only to cut surfaces. Once an entrance has been achieved, however, through mechanical damage or the bites of wire worms and other pests, the millipedes will eat out the entire centre of a potato and the damage they cause is often followed by fungal

attack. Furthermore, the fact that single potatoes have been found containing over a hundred BLANIULUS GUTTULATUS of all ages while the remainder of the crop was unharmed shows that they must have been attracted to a damaged tuber and could not have bred there (7).

Like woodlice, millipedes avoid the light, but with the exception of a directed response or "TAXIS" in those forms that possess eyes, their reactions are non-directional. When illuminated they crawl around until, by chance, they find themselves in darkness where they come to rest.

Although to millipedes, as to woodlice, humidity is the most important factor of the environment, as we have seen these animals are not able to find their way directly to damp places; instead, they are merely repelled kinetically by drought. Nevertheless this stereotyped and curiously negative behaviour is surprisingly effective in preventing them from wandering away from their normal habitats: but is does raise the problem of how dispersal can take place and new habitats become colonised (19).

There are a number of cases on record of millipedes, sometimes accompanied by centipedes and woodlice, migrating in vast armies. Occasionally they have crossed railways and been squashed in such numbers that locomotives have been impeded and sand has had to be strewn on the lines before their driving wheels would grip. At other times cattle have refused to graze on invaded pastures, wells have been filled with drowned corpses and workmen cultivating the fields have become nauseated and dizzy from the odour of millipedes crushed by their hoes. Such mass migrations, however, are of rare occurrence and local in extent, so that their net effect on distribution is probably negligible (6,27).

The explanation of the problem of distribution lies in the fact that, as already mentioned, the restraining mechanisms are somewhat relaxed during the night when the temperature falls and the humidity of the air increases. Thus it is at night that these creatures are enabled to disperse themselves and overcome the restrictions inherent in the physiology of their integuments.

IV. THE PARADOX OF RESPIRATION AND IMPERMEABILITY

The conflict between the incompatible requirements of respiratory exchange and prevention of water-loss in arthropods possessing a discrete cuticular wax layer has been illustrated by a comparison of the spiders AMAUROBIUS (= CINIFLO) FEROX and A. SIMILIS (26). Although there is some overlap in their territories, A. SIMILIS tends to inhabit somewhat drier environments than A. FEROX.

Aktograph experiments indicate that both species are nocturnal in habit, over 90 per cent of their activity taking place during the hours of darkness. When their water-relations are considered, however, it is found that there is a critical temperature at approximately 35° C above which both species quickly lose water by evaporation in dry air, but below this A. FEROX loses water more rapidly through its lung-books than does A. SIMILIS. The rate is almost doubled in both species when 10 per cent carbon dioxide is present, as this keeps the lung-books open.

Conversely the lenght of time or survival in air of 50 per cent relative humidity, and in dry air is longer in A. SIMILIS than in A. FEROX, death ensuing when from 20 to 25 per cent of total weight has been lost by evaporation.

A. SIMILIS "tires" more rapidly than A. FEROX when forced to run at full speed without stopping, but both species can run for long periods when supplied with oxygen. A. FEROX becomes anaesthetised more quickly in ether vapour and has the larger number of leaves in its lung-books. Its greater "stamina", therefore, depends upon a proportionately larger respiratory surface acquired at the expense of great dependence upon environmental humidity (26).

Diurnal rhythms of locomotory activity in animals are especially marked in desert regions where the climatic changes between day and night are particularly great (3, 4, 5, 18, 24, 37, 44 etc.). Microclimatic readings have indicated a considerable reduction in temperature fluctuations in the daytime retreats of deserticolous animals. For example, Williams (44) showed that in August whilst the surface of the sand in a wadi near Cairo varied from 17.5° to 58.2°C, at a depth of 18 cms. the range was only 29.3° to 37.8°C; whilst the effect of shading was to lower the surface temperatures some 20° C. Buxton (3) found that the surface of clay desert in southern Israel rose about 20° C beyond the shade temperature and quoted a daily range of temperature from -0.5° to 37.2° C in December at Bir Milgha in Southern Tripoli. Further examples of this kind can be obtained from the publications referred to above.

In addition to the considerable reduction in temperature extremes between day and night, only a few centimetres down a hole or within a small cave, a time-lag occurs in these sheltered habitats so that when their inhabitants emerge at dusk they may actually be leaving a warmer for a cooler environment.

In hot climates, survival depends upon avoiding desiccation and keeping cool. Consequently where water is in short supply, there must inevitably be a conflict between the requirements of conserving water for vital purposes and of transpiring it for cooling. Arthropods are too small to withstand transpiration for long and therefore can exist only by avoiding true desert conditions and their physiological

adaptations to desert conditions involve changes in degree rather than the evolution of new mechanisms. Thus, the behavioural responses and water-relations of the desert woodlouse, HEMILEPISTUS REAUMURI, and of centipedes such as SCOLOPENDRA CLAVIPES of North Africa are essentially similar to those of species from temperate regions.

Scorpions, however, present a more difficult problem. EUSCORPIUS GERMANUS from Italy and the Tunisian species, SCORPIO MAURUS, BUTHUS OCCITANUS and ANDROCTONUS AUSTRALIS are all markedly nocturnal and experimentally show well marked periodicity even under constant conditions. They can be arranged in a series as regards their rate of water-loss and time of survival in dry air and this series is in agreement with what is known of their ecology. The integuments of the three Tunisian species are extremely effective in preventing water-loss and their cuticular wax-layers have a critical temperature as high as 65° C. It is difficult, therefore, to ascribe any ecological function other than the avoidance of enemies to the markedly nocturnal behaviour of these animals which may be quite capable throughout much of the year of surviving the high temperatures and low humidity encountered on the surface of the desert sand during the daytime (24).

According to Vachon (40,41) however, scorpions were not originally characteristic of desert regions; they represent the remains of an ancient fauna which lived under quite different conditions of temperature and humidity and manage to survive in conditions of heat and drought because of their subterranean habitat and nocturnal habits. They are responsive to micro-climatic variations and each species seems to have to live and reproduce within characteristic ecological conditions varying within close limits (see also 27).

Desert beetles also show marked diurnal rhythms of locomotory activity and although the figures for water-loss from British and North African species are in the same order of magnitude it may be not only that there has been some adaptation of the water relations of the latter to desert life, but also that the types found in the desert are those whose physiology and behaviour are already such as would enable them to colonise arid regions (24). It must be remembered, however, that the ability to lose SOME water by evaporation and thus achieve reduction in temperature may be an important factor for all Arthropoda.

Buxton (4) comments upon the diurnal and seasonal appearance of desert beetles and has shown that many large Tenebrionidae, such as ADESMIA spp. which are conspicuous in North Africa and Israel at all times of the day in March and April, seek shelter under stones and bushes in May and June. Bodenheimer (1) has also shown that the time of maximum activity of desert beetles varies with the season.

It could scarcely be expected that the time of activity of terrestrial arthropods should be rigidly correlated with their rate of water-loss. Temperature tolerance, rate of water-loss in dry air, time of activity and the microclimatic conditions of the habitats in which they live are all factors of importance to be considered when assessing the adaptations of the various species to terrestrial life.

V. CONCLUSION

It would be a mistake to regard the absence of a cuticular wax layer as a primitive characteristic, although the forms that lack one are so restricted in their choice of environment that they cannot be regarded as entirely successful land animals. Rather, it seems that a particular method has been exploited for surviving the conditions of life on land.

The terrestrial ancestors of the arthropods may at first have been restrained by behaviour mechanisms to damp environments. Later some of their descendants, woodlice, centipedes and millipedes, exploited still further this form of terrestrial life; while others, the arachnids and insects, acquired waterproof integuments and the other physiological and morphological mechanisms that must accompany them. In the absence of more direct evidence, physiology and ecology can merely suggest the course that evolution may have followed.

The general speeding up of life in a medium of abundant oxygen and negligible viscosity has resulted in increased specialisation of the central nervous system, and only the size limit imposed by respiratory requirements and the necessity for growth by moulting may have prevented the arthropods from dominating the terrestrial environment to an even greater extent - possibly even to the exclusion of the vertebrates, including man.

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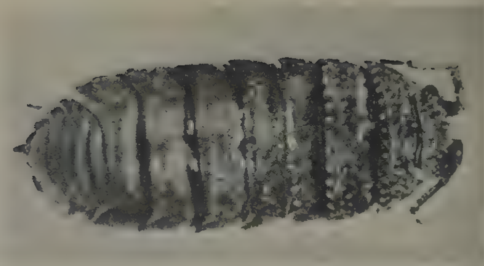
S U M M A R Y

A review is given of the adaptations of arthropods to life on land. The terrestrial Arthropoda are divided ecologically into two main groups. The first of these includes woodlice, centipedes, millipedes and their allies which lose water rapidly in dry air and consequently are restricted to damp, dark habitats which they leave only at night when the temperature falls and the relative humidity of the air rises. The second group includes most insects and Arachnida: these are comparatively independent of moist surroundings because their integument possesses an impervious layer of wax which prevents desiccation.

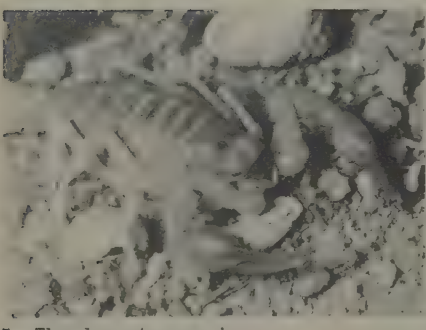
1. Woodlice on a wall at night



2. The desert woodlouse (HEMILEPISTUS REAUMURI)
(much enlarged)

3. Apparatus for microclimatic measurement
Left, electrical thermometer employing thermistors; right, electrical resistance hygrometer.

4. The wall spider (AMAUROBIUS FEROX, male)
(enlarged)



5. The desert scorpion
(ANDROCTONUS AUSTRALIS)

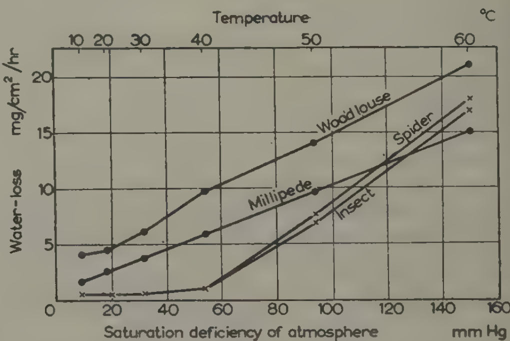


FIG. 6 Rate of water-loss in dry air at different temperatures, and corresponding saturation deficiencies, from a woodlouse (*Porcellio*), millipede (*Oxidus*), spider (*Lycosa*) and insect (*Pieris* larva). In the woodlouse and millipede the rate of water-loss is proportional to the saturation deficiency of the atmosphere, but in the spider and insect it is negligible below about 30° C., the critical temperature at which their epicuticular wax-layers become porous. Rate of water-loss is expressed in milligrams per square centimetre of surface area per hour.

Section C : Veterinary bioclimatology

I.J.B.B. vol. III, 1959, part III, Section C

CORRELATION OF BODY TEMPERATURE AND OF RESPIRATION RATE OF SWINE WITH ENVIRONMENTAL TEMPERATURE

by

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ABSTRACT

Correlation analyses were carried out to determine relation of body temperature and respiration rate of three breeds of swine to the environmental temperature. Coefficients of regression were determined for a prediction equation of the form:

$$y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5$$

where, y = body temperature

x_1 = respiration rate

x_2 = body weight

x_3 = sex

x_4 = environmental temperature

$x_5 = x_1 x_4$

I. INTRODUCTION

It is generally conceded that limited fluctuations in environmental temperature does not materially alter body temperature of warm-blooded animals (1, 2, 4). Such fluctuations activate thermoregulatory apparatus to counteract the external change in environment. Animals differ in their ability to dissipate heat due to their hereditary make-up, state of health and nutritional regime. Heat exchange in the live animal theoretically can be altered by change in body surface, change in color and amount of body covering, vasodilation or constriction, hormonal change influencing metabolic rate, increased vaporization through sweating and by acceleration of respiration rate.

It has generally been assumed that swine are affected more by summer temperatures than any of the other farm animals. The hog is a nonsweating animal and in addition, with increasing weight, the fatty covering is thought to present a barrier to the loss of body heat.

A review of the literature indicates there is insufficient knowledge of the fundamental physiology of swine and farm animals in general in regards to adapting to unfavorable environmental temperature to make a valid comparison of breeds.

The objects of this experiment were to:

(1) determine the correlation of body temperature with respiration rate and environmental temperature in three different breeds of swine;
(2) evaluate the coefficients of the regression equation for predicting body temperature of the three breeds - Duroc Jersey, Chester White and Yorkshire

II. EXPERIMENTAL PROCEDURE

This experiment was conducted during two summer periods - June through August 1955 and 1956 - on the Livestock Experimental Farm of Purdue University at Lafayette, Indiana. Data were obtained on

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body temperature and respiration rate for hogs of the three breeds over a range of environmental temperatures extending from 60° to 95° F (15.6° to 35° C).

Rectal temperatures were obtained on the resting hog by inserting a clinical fever thermometer to a depth of approximately 4 inches and reading to the nearest one-tenth degree Fahrenheit. Respiration rate was determined on the resting hog by a one minute visual count. The ambient temperature was then secured from the reading of a mercural thermometer housed in a standard louvered instrument shelter located in the vicinity of the experimental pens. The thermometer was located approximately 5 feet above the ground. Pigs of each breed were subjected to identical environmental conditions.

During the 1955 trial, pigs had access to self-feeders and automatic waterers and were fed a ration of yellow shelled corn and protein supplement free choice. [1)]

The protein supplement was composed of: Soybean oil meal, 46.9%; meat and bone scraps, 20.0 %; fish meal, 20.0%; alfalfa meal, 10.0%; salt, 2.0%; antibiotics 3.3 [2)], 0.85%; and fortafeed [3)], 0.25%.

Pigs used in the 1956 trials were self-fed with a complete mixed ration composed of: Ground yellow corn, 64%; ground oats, 15%; supplement V [4)], 19%; and mineral mixture [5)]. 2%.

Individual weights, average feed consumption and feed efficiency were obtained at weekly intervals. The average weight of pigs of each breed increased from an initial weight of 75 lbs. to 200 lbs. at the end of the experiment.

Three breeds of hogs were represented in this work. There were 37 Duroc, 110 Chester White and 95 Yorkshire pigs in the experiment. During the period more than 400 individual readings were made to determine rectal tenperature and respiration rate. These data were then analyzed to determine the relationship of rectal temperature to respiration rate, weight of pig, sex of pig and environmental temperature.

III. RESULTS

In the preliminary analysis of the data all combinations of pairs of the independent variables were plotted vs. rectal temperature to obtain an indication of the need for interaction terms in the regression equation.

This was done by plotting the points of one of the independent variables and rectal temperature for various values of the second independent variable. If these relationships between the first independent variable and rectal temperature changed depending on the value of the second independent variable, this was taken as an indication of the need for an interaction term.

Of the combinations of independent variable, only respiration rate and ambient temperature appeared to be important. In this case, the increase in rectal temperature associated with an increase in respiration rate was greater for high ambient temperatures than for low ambient temperatures.

By a regression analysis, coefficients were determined for an equation of the form:

$$y = a + b_1 x_1 + b_2 x_2 + b_3 x_3 + b_4 x_4 + b_5 x_5$$

where y = rectal temperature in degrees Fahrenheit

x_1 = respiration rate, respirations per minute

x_2 = body weight in pounds

x_3 = sex, where 1 = females and 2 = castrate males

x_4 = environmental temperature in degrees Fahrenheit

$x_5 = x_1 x_4$

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1) Feed was available at all times and temperature and respiration data were collected only on those animals lying quietly in the shade. Individuals from all breeds were examined within a period of a few minutes. Data were collected between the hours of 8 a.m. and 4 p.m. local time.
2) Pfizer's 3.3 contained 3 grams of terramycin and 3 milligrams of Vitamin B12 per pound which supplied 50 grams of terramycin per ton and 50 milligrams of Vitamin B12 per ton.
3) Fortafeed (Lederle) vitamin supplement contained 2, 4 and 9 grams of riboflavin, calcium pantothenate and niacin, respectively, per pound of supplement.
4) Purdue Supplement V had the following composition: 40% soybean oil meal, 25% meat and bone scraps, 25% fish meal, 10% cottonseed meal.
5) Mineral mixture was composed of 40% ground limestone, 40% steamed bonemeal, 20% iodized salt.

Table I shows the simple correlation coefficients of each of the independent variables with rectal temperature for the Duroc, Chester White and Yorkshire breeds, respectively, plus values for all breeds combined.

Table 2 gives the square of the multiple correlation coefficients which indicate the relative amount of the variation of rectal temperature accounted for by the factor studied. For example, the value 0.7263 for Durocs indicates that approximately 73% of the variation of rectal temperature of the Durocs is accounted for by the change in respiration rate, weight, sex, ambient temperature and respiration rate X ambient temperature. The value 0.6864 indicates that approximately 69% of the variation of rectal temperature in the Durocs can be accounted for by variation in respiration rate and environmental temperature. A comparison of R^2 for Durocs with that for Yorkshire (see Table 4) shows a marked difference between breeds. Approximately 46% of the variation of rectal temperature in Yorkshire was accounted for by the five variables studied, but only 37% when x_5 (the interaction term) was removed. When respiration rate and environmental temperature were the only variables included in the regression equation, 34% of the rectal temperature variation was accounted for.

The tables of simple correlation coefficients (Tables 2, 3 and 4) show that respiration rate and rectal temperature of the Chester White and Duroc hogs are more highly correlated than are those variables in the Yorkshire hogs. Table 5 shows the regression coefficients and intercepts for the variables when data for all breeds were combined. The mean values of body temperature by breeds for the three temperature levels are shown in Table 6.

IV. DISCUSSION

Dukes (4) reporting on work by Palmer gives the average body temperature of the pigs as 102.5°F (39.2°C) with a range of 101.6° to 103,6° F (38.7° to 39.8° C). Brody (2) reports the temperature of the pigs as 103° F (39.4°C) and includes the pig along with cattle, sheep, goats, dogs and rabbits within a temperature range of 100° to 103° F (37.8° to 39.4° C).

Findlay (6) reviewing the findings of several investigators reports the range of rectal temperature for the pigs from 98.3° to 104° F (36.8° to 40.0°C). Heitman et al (7, 8) using a psychrometric room for temperature control studies on swine found that as the air increased from 40° to 115° F (4.4° to 46.1° C) the rectal temperature of the pig also increased. The heavier pigs showed a greater increase in rectal temperature with increasing environmental temperature.

Respiration rate in swine, as in other nonsweating species, rises rapidly with increasing environmental temperature. Brody (2) points out that in swine the respiration rate rises rapidly with increasing environmental temperature to compensate for the inability to loose heat by evaporation of sweat and to increase the vaporization rate from the respiratory passage. Dukes (4) reports the respiration rate of the resting mature hog at 8-18 rpm. Robinson and Lee (12) noted an increase in respiration when pigs were exposed to 75° and 80° F (23.9° and 26.7° C). At temperatures of 85°, 90° and 95° F (29.4°, 32.2° and 35.0° C) there was about a fourfold increase in the respiration rate.

On the basis of average body temperature at three levels of environmental temperature, Yorkshire pigs appeared to be no more sensitive to high environmental temperature than Durocs and Chester Whites. Since only 46% of the variation in body temperature of Yorkshire pigs was accounted for (see Table 4) by the variables studied, it appears that one or more important factors have been excluded. It had previously been noted that Yorkshire swine show a greater reduction in feed consumption in hot weather than do the other breeds. During a 56-day period, June 20 to August 15, Duroc, Chester White and Yorkshire pigs consumed an average of 5.50, 4.83 and 3.68 lbs. per day, respectively. It would appear that the Yorkshire's sensitivity to high temperature is mediated through reduced feed consumption, while the Duroc and Chester White pigs maintain high feed consumption but mainly relatively constant body temperature by decreased activity and increased respiration rate.

No endocrinology studies were made to explain the lower mean body temperature in an environment of 70° to 80° F (21.1° to 26.7° C) than in one of 60° to 70° F (15.6° to 21.1°C) although the data suggest an increased thyroid activity due to the lower environmental temperatures. The environmental temperature of 80° to 90° F (26.7° to 32.2° C) appears to be sufficiently high to obscure the reduced thyroid activity thus resulting in a higher body temperature.

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TABLE 1. SIMPLE CORRELATION COEFFICIENTS BETWEEN SELECTED VARIABLES [1)]

Variables	Duroc Jersey	Chester White	Yorkshire	All Breeds Combined
r_{01}	.83	.78	.54	.74
r_{02}	.24	-.17	-.28	-.07
r_{03}	-.10	-.09	.00	-.21
r_{04}	.44	.65	.52	.58
r_{05}	.83	.80	.57	.75

1) 1, respiration rate; 2, body weight; 3, sex; 4, environmental temperature; 5, x_1x_4.

TABLE 2. REGRESSION COEFFICIENTS [1)] (Duroc trial)

Explained Variation [2)] R^2	Respiration b_1	Weight b_2	Sex b_3	Environmental Temperature b_4	Interaction b_5	Intercept a
0.7263	- 0.0347	0.0013	-0.5940	- 0.0275	0.0007	0.4536
0.7111	0.0217	0.0025	-0.6019	0.0229	------	0.9937
0.7023	- 0.3504	-0.0100	------	- 0.3534	0.0066	0.5330
0.7258	- 0.0366	------	-0.5714	- 0.0246	0.0007	0.4475
0.7019	- 0.3347	------	------	- 0.3804	0.0065	0.5406
0.6864	0.2252	------	------	0.1689	------	0.6778

1) Coefficients showing rate of change of body temperature with respiration rate b_1, weight b_2, sex b_3, environmental temperature b_4, and interaction b_5.
2) Percent of variation in body temperature accounted for by the variables shown.

TABLE 3. REGRESSION COEFFICIENTS [1] (Chester White trial)

Explained Variation [2] R^2	Respiration b_1	Weight b_2	Sex b_3	Environmental Temperature b_4	Interaction b_5	Intercept a
0.6611	- 0.3588	-0.0233	-0.9864	0.0137	0.0059	0.2253
0.6401	0.1310	-0.0363	-0.8607	0.3498	------	-0.1536
0.6593	- 0.3532	-0.0225	------	0.0456	0.0057	0.2113
0.6570	- 0.4096	------	0.9177	-0.0103	0.0064	0.2329
0.6554	- 0.4029	------	------	-0.0007	0.0063	0.2196
0.6284	0.1353	------	------	0.3324	------	-0.5418

1) Coefficients showing rate of change of body temperature with respiration rate b_1, weight b_2, sex b_3, environmental temperature b_4, and interaction b_5.
2) Percent of variation in body temperature accounted for by the variables shown.

TABLE 4. REGRESSION COEFFICIENTS [1] (Yorkshire trial)

Explained Variation [2] R^2	Respiration b_1	Weight b_2	Sex b_3	Environmental Temperature b_4	Interaction b_5	Intercept a
0.4636	- 0.1173	-0.0046	-0.1346	-0.0035	0.0015	0.3377
0.3702	0.0085	-0.0090	-0.1838	0.0506	------	-0.6634
0.4602	- 0.1189	-0.0039	------	-0.0052	0.0015	0.3343
0.4564	- 0.1262	------	-0.0912	-0.0066	0.0016	0.2982
0.4548	- 0.1263	------	------	-0.0075	0.0016	0.2999
0.3390	0.0923	------	------	0.5155	------	-0.2101

1) Coefficients showing rate of change of body temperature with respiration rate b_1, weight b_2, sex b_3, environmental temperature b_4, and interaction b_5.
2) Percent of variation in body temperature accounted for by the variables shown.

TABLE 5. REGRESSION COEFFICIENTS [1] (All Breeds Combined)

Explained Variation [2] R^2	Respiration b_1	Weight b_2	Sex b_3	Environmental Temperature b_4	Interaction b_5	Intercept a
0.6028	- 0.0399	-0.0030	-0.4242	0.0035	0.0007	0.2388
0.5823	0.0159	-0.0013	-0.3830	0.0390	------	-0.5642
0.5785	- 0.3239	-0.0244	------	0.0438	0.0058	0.1969
0.5988	- 0.0401	------	-0.4115	-0.0006	0.0009	0.2292
0.5176	- 0.3268	------	------	0.0100	------	0.1899
0.5600	0.1702	------	------	0.3275	------	-0.7353

1) Coefficients showing rate of change of body temperature with respiration rate b_1, weight b_2, sex b_3, environmental temperature b_4, and interaction b_5.
2) Percent of variation in body temperature accounted for by the variables shown.

TABLE 6. BODY TEMPERATURE

Environmental Temperature	Breed	Number Measurements	Body Temperature Degrees Fahrenheit	Degrees Centigrade
60°-70° F (15.6°-21.1° C)	Duroc	86	104.1	40.0
	Chester White	63	103.3	39.6
	Yorkshire	69	102.6	39.2
70°-80° F (21.1°-26.7° C)	Duroc	68	103.3	39.6
	Chester White	25	102.7	39.3
	Yorkshire	36	102.1	38.9
85°-95° F (29.4°-35.0° C)	Duroc	81	104.2	40.1
	Chester White	25	104.3	40.2
	Yorkshire	13	103.9	39.9

I.J.B.B. Vol. III, 1959, part III, section C

ZOOLOGICAL BIOCLIMATOLOGY
Section C: Veterinary bioclimatology

THE INFLUENCE OF CLIMATIC FACTORS ON THE HEAT BALANCE AND MILK YIELD OF THE COW IN RELATION TO THE DESIGN OF FARM BUILDINGS IN THE NETHERLANDS

by

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I. INTRODUCTION

During the war many farm buildings in the Netherlands were destroyed and since farms had also to be built in the new land won from the sea (the polders) the need arose for an investigation on the influence of climatic factors on the heat balance and milk yield of the cow so that such new buildings could be efficiently designed for optimum milk production.

In 1954 the author was asked to make such an investigation on behalf of the Organisation for Applied Scientific Research (T.N.O.) and this paper deals with the methods used and the results obtained.

II. THE EFFECTS OF CLIMATE ON THE COW

The general effects of climate on cattle have been reviewed by Findlay and Beakley (2) who showed, in general, that cows are better adapted to low than to high temperatures. Worstell and Brody (7) have shown that the comfort zone for cattle lies between 0^{0} and 15.5^{0}C. Two reasons can be adduced for the ill-adaption of cattle to hot environments. First, the high level of heat production, e.g. 10,000 Kcal/day for a non-lactating, non-gestating cow or 20,000 Kcal/day for a cow yielding 20 kg milk per day. Second, cows are a poorly-sweating species of mammalia, skin moisture vaporisation attaining a maximum at only 17^{0} C ambient temperature (4).

III. METHODS

Two experimental methods are available for studying the influence of climate on the milk yield during winter months. The first is to identify the climate within barns and ascertain their influence on the cow and its production. The second method is more indirect and consists of correlating periods of low temperature e.g. during frost, with the amount of milk sent to the factories.

Fig. 1 and 2 show the relation between the supply of milk to the factories for the whole country and the mean weekly temperature. During some years there was an indication, that temperatures below zero influenced the supply of milk. Other factors, for instance the time of calving, especially at the beginning of February, had much more influence, but in relation to other years the period of February 1956, associated with very low temperatures, had a significant effect on the supply of milk. The supply of milk during the first week in February with temperatures below zero was 3.7% too low in relation to the supply of milk during January 1955 and the supply of milk during the last week of January which did not have low temperatures.

This 3.7% fall indicates that during the first week of February 1956, the supply of milk was 2.284.000 kg/week too low, or about 0.5 kg/cow/day.

It is not known whether this effect was due to climatic factors (low temperatures in the stable), or to changes in the rations (the latter is the case in the Netherlands, if the silage is frozen and cannot be given to the cows).

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This method can therefore give only an indication as opposed to directly measuring the effect of climate.

The non-evaporative heat loss was measured with a Hatfield J.L.C. heat flow disc (low temperature type) (6). To ascertain the influence of temperature and humidity on the milk yield, the cows in the barns were divided into two groups, one group with a high level, the other with a low level of production. Using the table for "standard cow production", the yield per cow was normalized on age and stage of lactation.

If the groups are big enough they are comparable. The table for standard cow production is based on the fact, that the highest yield of a cow in the Netherlands is generally reached at 8 yrs and 2 mths. This is taken as 100%. Each part of the lactation curve of a cow can be taken as a percentage of the top level of production. Doeksen and Heyboer (1) drew up this table in 1954 using hundreds of Dutch-Friesian cows. The basis of this method was that the influence of climatic factors on a cow with a high level of production, and therefore with a much higher heat production and heat loss, is not the same as that on a cow with a low level of production. In barns with, for instance, a high temperature, the cow with a high level of production is more likely to lose its heat balance than a cow with a low level of production. The depressing effect of high temperatures will be greater on the cow with the high level of production. Because of the normalisation tables, changes in milk production, due, for instance, to the quality of the food, will be equal in the two groups. Influences due to climatic factors would tend to depress the production of the group with a high level of production and not the one with a low level of production.

To check the accuracy of the heat flow disc, it was tested in a respiration (climatic) chamber of the Laboratory of Animal Physiology of the Agricultural College at Wageningen.

The heat loss to the ground was measured using a plastic sac filled with water at a constant temperature of 30° C. The heat flow to the ground beneath the sac was measured with the disc.

IV. THE MEASUREMENTS WITH THE HEAT FLOW METER

Using the heat flow disc the non-evaporative cooling can be measured at several environmental temperatures, so ascertaining at which temperature the cow is in thermo-neutrality. The basis of these measurements may be seen in Fig. 3 based on the measurements of Kibler and Brody 1950. The non-evaporative cooling is zero when the skin temperatures equal environmental temperatures. Decreasing the environmental temperature increases the non-evaporative heat loss. Below a certain temperature increase in non-evaporative heat loss cannot continue unless the body temperature decreases. Consequently the non-evaporative heat loss is limited (point P). This point represents thermo-neutrality since heat production should be equal or nearly equal to heat loss.

By measuring the non-evaporative cooling of the trunk, it is possible to ascertain the temperature corresponding to point P.

Before this was done the heat flow meter was tested. The non-evaporative cooling of the surface of the pelvis between the tuber coxae and the tuber ischiadicum, used as the place for routine measurements, was compared with the heat loss of other places on the surface of the trunk. No significant differences were found.

The non-evaporative cooling was then measured at several temperatures on more than 60 cows. It was found that the non-evaporative cooling is limited to about 8° - 9° C. Temperatures below zero did not increase the non-evaporative cooling but low temperatures and wind did. Figs. 4 and 5 show these results.

In the respiration chamber the sun, of the non-evaporative cooling measured with the heat flow meter and corrected for total surface, and the evaporative cooling, condensed water, were measured at various temperatures and were found to be comparable to the heat production as shown in Table 1.

The milk yield of cows housed in the open shed was unaffected during periods of very low temperatures and the animals were apparently healthy although temperature gradients between body and environment were about 50° C. In an attempt to objectively ascertain the comfort of the cow, living in an environment with temperatures of - 10° C, the following experiment was carried out. During a very severe frost period (Febr. 1956), an open shed was divided into three parts and 5 heating elements switched on successively above each part. Every 15 min. it was noted which cows preferred the warmth of the heating elements. It was found that when the air temperature was about -10° C the cows with the lowest heat production i.e. heat loss in the zone of thermo-neutrality preferred the heat of the elements significantly more than cows with higher heat production. When the conditions were particularly severe, e.g. low temperatures and wind, it was found that the "boss cows" scared away the other animals.

V. HEAT BALANCE AND THE FUNCTION OF THE SKIN, THE COAT AND CONDUCTION TO THE GROUND

Although on many farms the cows are clipped in the autumn, on others this does not occur. To obtain information about the insulating properties of the coat in relation to the heat balance of the animals, some measurements with the heat flow meter were carried out.

The non-evaporative cooling of six cows with a "normal" coat (end of November) was measured with the heat flow meter. The procedure was repeated after clipping a small part of the coat and after complete clipping of the animal. The results are given in Table 2. The increase of the non-evaporative cooling after clipping a very small part of the coat of 6 cows averaged 18.2 kcal/m2/hour. After complete clipping of the animals the non-avaporative cooling returned to the value obtained before clipping. In terms of non-evaporative cooling/cow/kcal/m2/hour, the animal with the lowest heat loss had the best insulation.

The return of the non-evaporative cooling, after complete clipping of the animals to the normal value indicates, that the animals can regulate the non-evaporative cooling adequately by vasoconstriction.

Non-evaporative cooling was also found to drop about 20 kcal/m2/hour after injection of 4 ml adrenaline (1 : 1000, 32° C), subcutaneously, under the disc. The temperature of the environment was about 12° C. Two animals were used.

During the experiments in the respiration chamber it was found that the non-evaporative cooling was higher when an animal was lying than when standing. This unexpected result was found to be due to the very good insulation of the floor of the respiration chamber. Measurements have proved that a lying animal does not lose enough heat if the ground beneath is well-insulated. This is compensated for by an increase in the non-evaporative cooling through the skin to the air.

This finding suggests that in a warm climate the insulation of the ground beneath should be poor and in a cold environment the ground should be well-insulated. Measurements with the heat flow meter showed that if a small layer of straw is put on the floor of a conventional barn, this can reduce the heatflow to the ground beneath from 150 kcal/m2/hr to 40 kcal/m2/hr.

VI. STABLE CLIMATE AND ITS INFLUENCE ON MILK PRODUCTION

To collect information about the role the climatic conditions play in the Dutch barns, the temperature and humidity were measured twice a day, in about 12 stables during the winter of 1954-1955 and 1955-1956.

It was found, that especially in spring, though also in autumn, "tropical" conditions are not uncommon. This can be seen in Fig. 6. These high temperatures, with corresponding high humidities, have a depressing effect on the milk yield of a cow with a high level of production (20 kg milk/day or more). As previously stated, this was found with the help of the tables for "standard cow production". Before these tables were used, they were tested. Fig. 7 assesses the value of the tables. Two groups of cows, one with a high level of production and one with a low level of production on an ordinary Friesian farm were used. It can be seen, that during the time the animals were in the pasture the difference between the two groups was constant. Only during the time the animals were in the stable there was a difference. It can also be seen, that during pasture time changes in the ration are nearly equal for both groups.

In the stables where the temperatures were measured comparisons between the standard cow production of groups with a high level of production and groups with a low level of production were made. It was found that the production of the group with a high level of production decreased when the animals were exposed to temperatures higher than 16-17° C. Higher temperatures with high humidities adversely affected the persistency of the lactation curve of the cows.

The lower temperatures during the period with frost in February 1956 had a depressing effect on the milk yield of all cows in the open shed and in some conventional barns during the first two days. The milk yield of the cows in the open shed did not further decline, but in two closed barns, where the animals were able to move freely, the milk production decreased further during the following days when the temperatures were much higher than in the open sheds. There was a marked correlation between the fluctuations in milk production of the cows in these two independent groups ($r = \pm 0.69$). It was found that the temperatures obtaining during the previous 5 days were the cause of these fluctuations. Lee, McMillan, McDowell and Fohrman (5) found the same delayed effect under summer conditions in the U.S.A. 't Hart and Kemp (3) also found a delay in the influence of the temperature of the previous 5 days when there was an outbreak of grass tetany in the Netherlands.

In conventional barns there is an indication that the milk yield of the cows with a low level

of production decreases during periods of frost.

The difference between the decrease of the milk yield of the cows in the two barns which were closed and where the animals were free to move and that of the undisturbed production of the cows in the open shed with much lower air tempeartures is striking. The direct solar radiation on the cows in the open shed may be an important factor. During the experiment using heating elements it was noted that during the day the cows stood almost all day in the sun.

VII. SUMMARY

The results and methods of an investigation on the influence of climatic factors on the heat-balance and milk yield of the cow are described. The non-evaporative cooling was measured at several environmental temperatures with use of a heat flowmeter. The observation was made, that to about 8-9° C the increase of the non-evaporative cooling of the trunk (at decreasing environmental temperatures) was limited.

In spring and autumn the climatical conditions in the stables in the Netherlands were in some cases "tropical". These high temperatures, with corresponding high humidities, have a depressing effect on the milk yield of a cow with a high level of production (20 kg milk/day or more).

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Table 1. Comparison of the heatproduction with the evaporative cooling and the non-evaporative cooling (part of the skin between the tuber coxae and the tuber ischiadicum).

Chamber temp. °C	Rel. humidity %	Heatproduction Cal/hr standing and lying	Heatproduction Cal/hr standing	Evaporative cooling Cal/hr	Non-evaporative cooling Cal/hr	Total heatloss Cal/hr	Body temp. 10 hr	Body temp. 17 hr
15	74	804	844.2	232,2	587,7	819,9	38.6	38.2
11	81	797	836.8	186.1	633.7	819.8	38.5	38.8
5	79	772	810.6*	200.1**	648.5	848.6	38.8	38.8
25	75	780	819	427.4	387.2	814.6	38.8	38.8

* The lowest heat production at 5°C is difficult to understand but, as during the first experiments the animal was not completely accustomed to the chamber, it was rather restless and this explains the slightly higher heat production.

** The measured evaporative cooling (condensed water) is too high. This is due to the fact that the temperature of 5°C was the limite of cooling capacity of the chamber; this caused a certain error.

Table 2. Influence of the coat on the non-evaporative cooling of six Dutch - Friesian cows. The measurements were carried out at a stable temperature of 12.6°C. The total surface is calculated from the weight the formule $0 = 0.15\ G^{0,56}$

Number of cow	Non-evaporative cooling before shaving Kcal/hr		Non-evaporative cooling after shaving 15 cm2 of the coat Kcal/hr		Increase of non-evaporative cooling Kcal/hr		Non-evaporative cooling after complete shaving Kcal/hr		Increase of non-evaporative cooling Kcal/hr	
Identical twin:	per m2	Total surface	per m2	Total surface	per m2	Total surface	per m2	Total surface	per m2	Total surface
8714	109.4	521.8	131.1	625.3	21.7	103.5	110.3	526.8	0.9	4.0
53493	113.6	586.1	129.5	668.2	15.9	82.1	118.4	610.0	4.8	24.9
S. 321	104.7	513.0	128.2	628.1	23.5	115.1	104.3	512.0	-0.4	-0.9
19	112.4	551.9	126.2	619.6	13.8	67.7	118.1	579.8	5.7	27.9
20	110.2	556.5	127.1	641.8	16.9	85.3	115.5	583.2	5.3	26.7
4994	109.4	547.0	126.7	633.5	17.3	86.5	113.6	568.0	4.2	21.0
Average	109.9	546.0	128.1	636.0	18.2	90.0	113.3	563.2	3.4	17.2

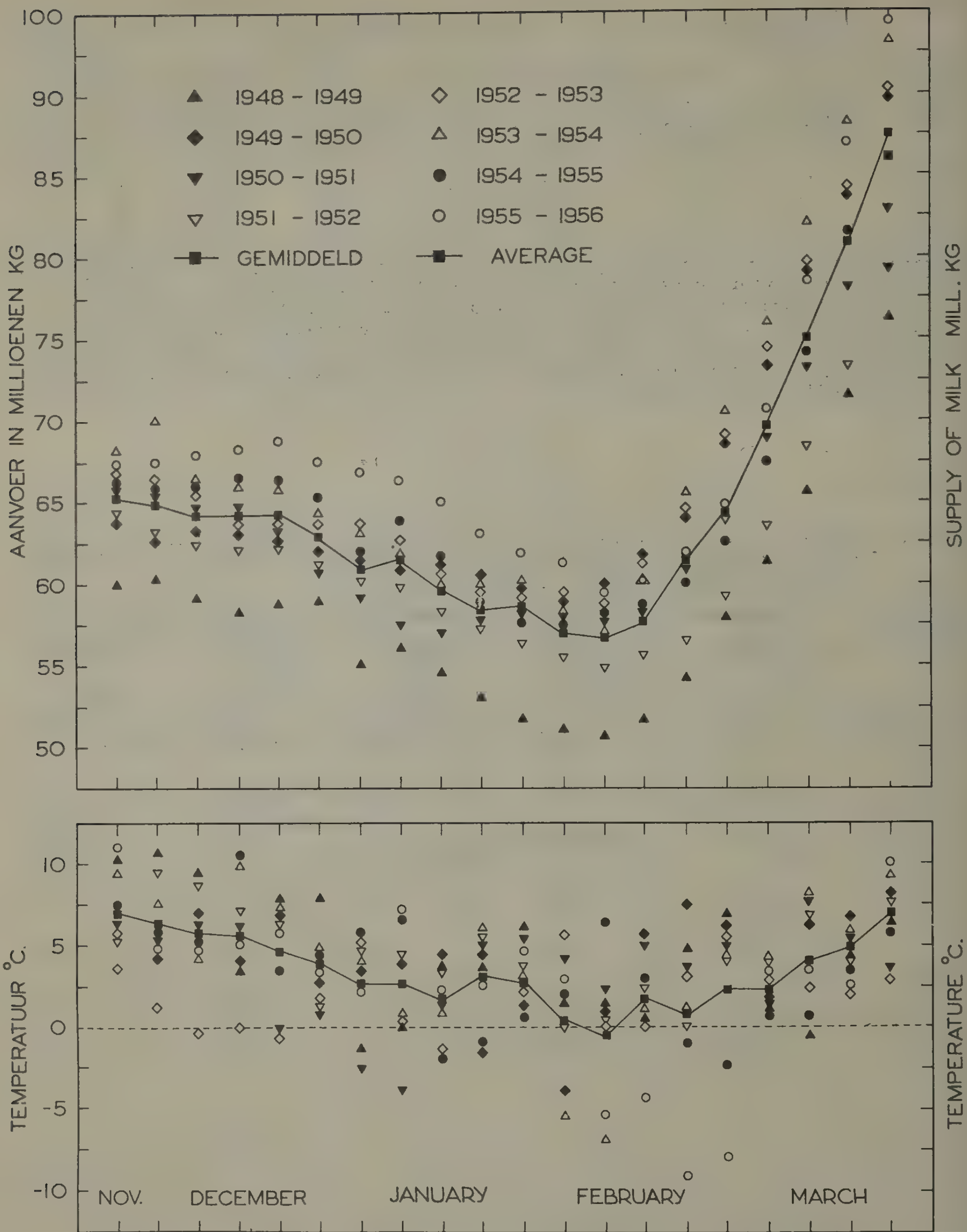

Fig. 1. Relation between the supply of milk to the factories for the whole country and the average weekly temperature during the winters 1948-1949 up to 1955-1956.

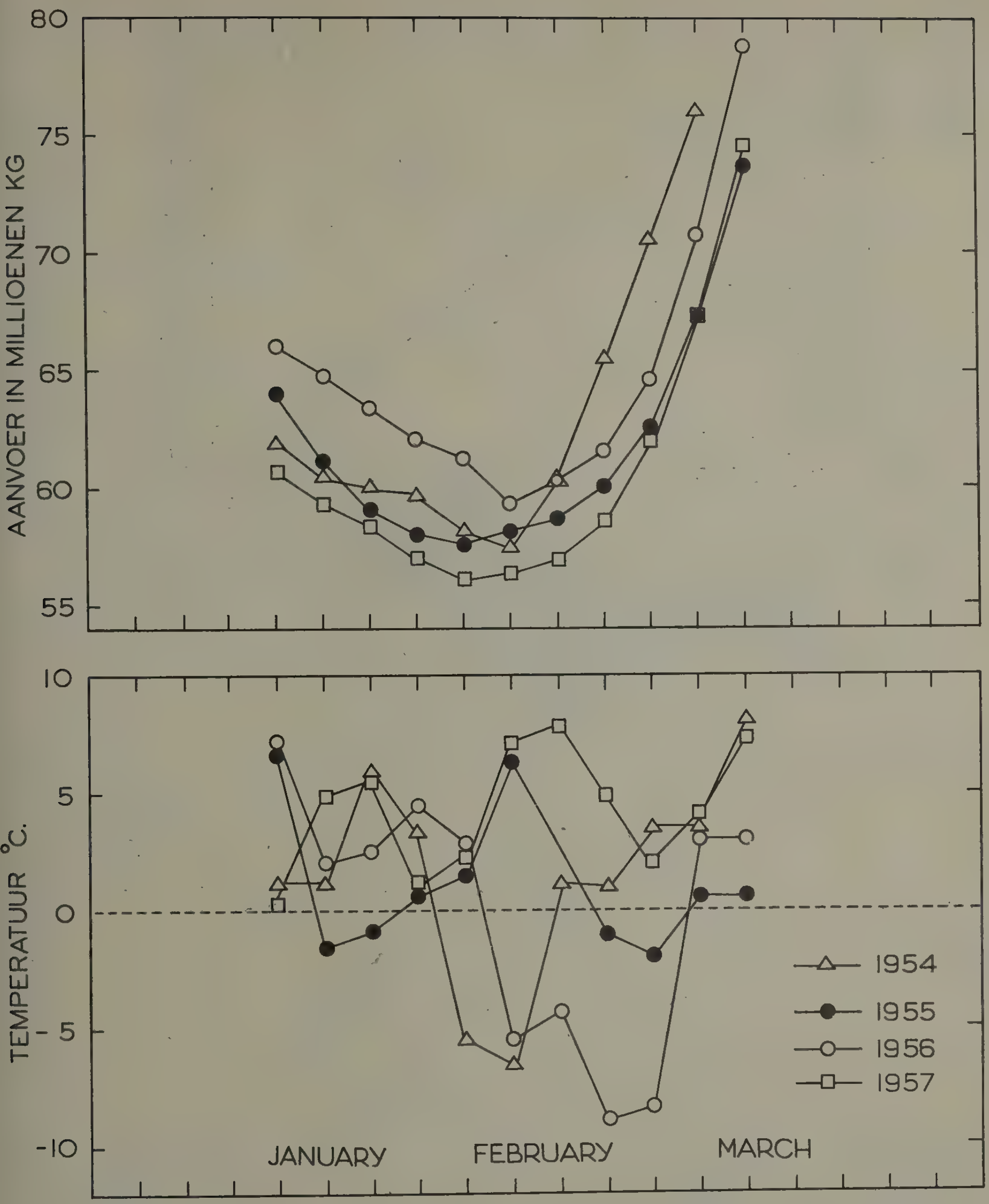

Fig. 2. Relation between the supply of milk to the factories for the whole country and the average weekly temperature during the winters 1953-1954 up to 1956-1957.

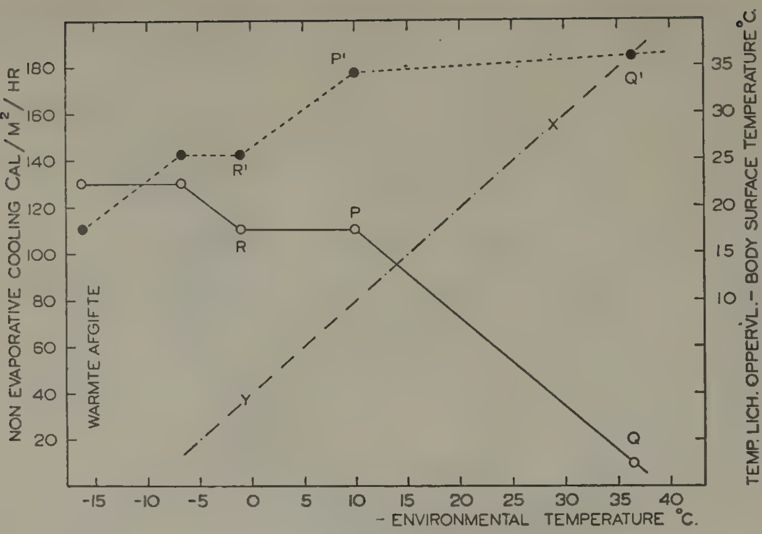

Fig. 3. The relationship between surface temperature and non-evaporative cooling, theoretically to be expected at different environmental temperatures.
Q.P.R. = non-evaporative cooling
$Q^1.P^1.R^1$ = skin temperatures
XY = relation between environmental temperatures and skin temperatures.

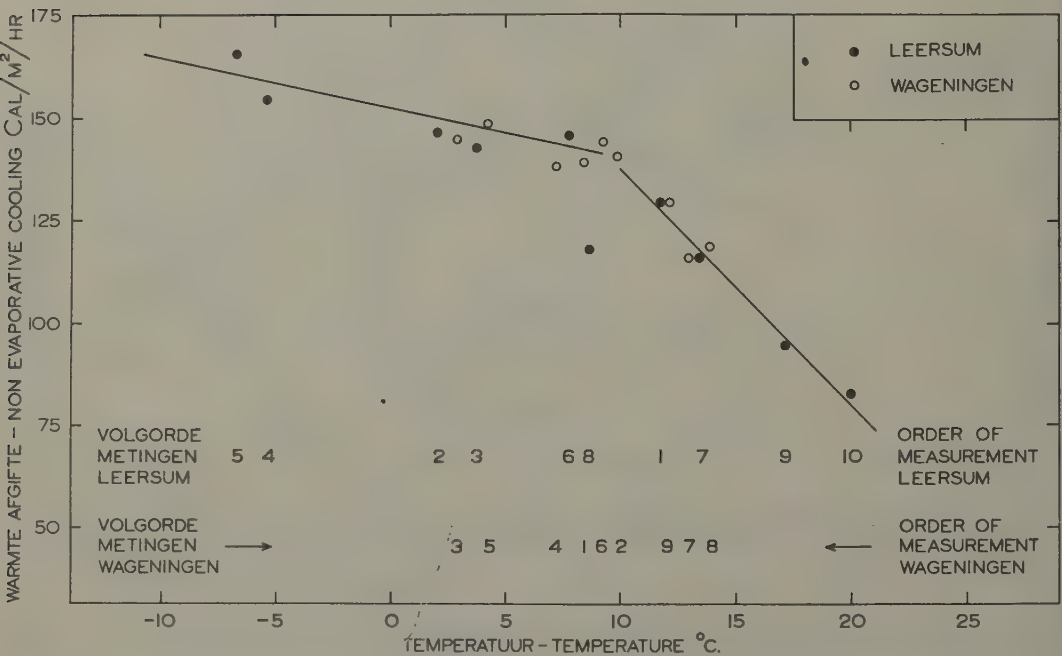

Fig. 4. The non-evaporative cooling (surface of the skin between tuber coxae and tuber ischiadicum) of 20 M.R.IJ. cows housed in an open shed at Leersum and 16 Dutch-Friesian cows in a loose house at Wageningen.

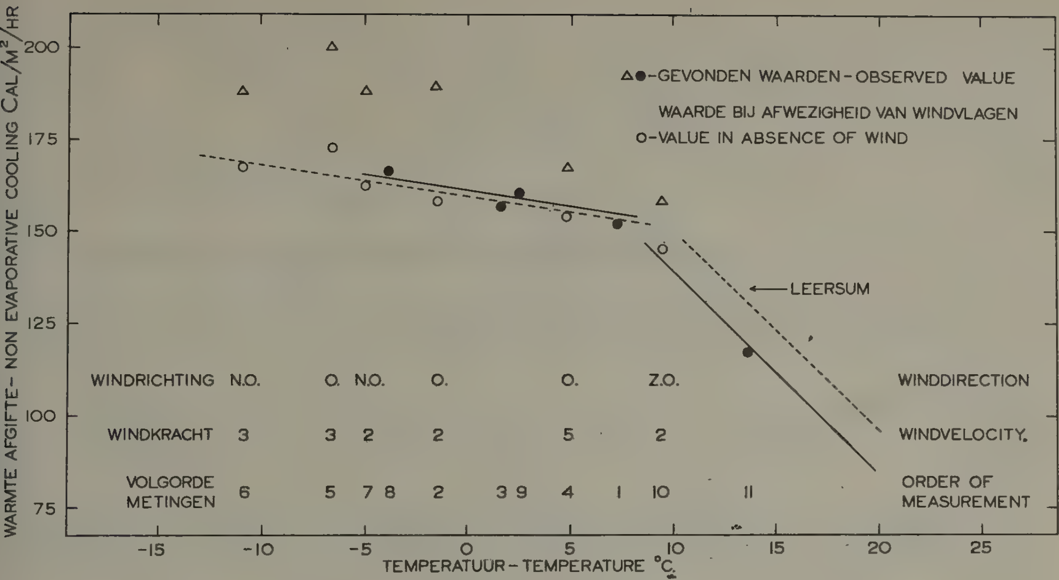

Fig. 5. The non-evaporative cooling (surface of the skin between tuber coxae and tuber ischiadicum) of 13 M.R.IJ. cows in an open shed at Diessen.

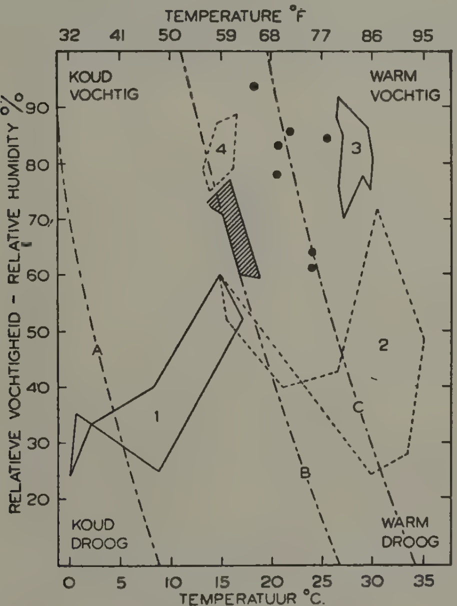

Fig. 6. Climograph for cattle in Europe and Asia (modified, Wright 1954). The climograph for a stable at Rijperkerk is drawn in the figure (hatched). The points represent the highest temperatures, with the corresponding humidities, found in the stables during the period of the investigation.
The lines with the weak curves represent the limits of the comfort zone of men C, and of cows (Kibler and Brody 1953): A and B.
1. Lhasa, Tibet: Yak; 2, Delhi, India: Large Indian Zebu; 3. Cochin, South-India: Dwarf Indian Zebu; 4. Nuwera Eliya, Ceylon: imported European cattle.
Hatched: stable climate in a Dutch farm.

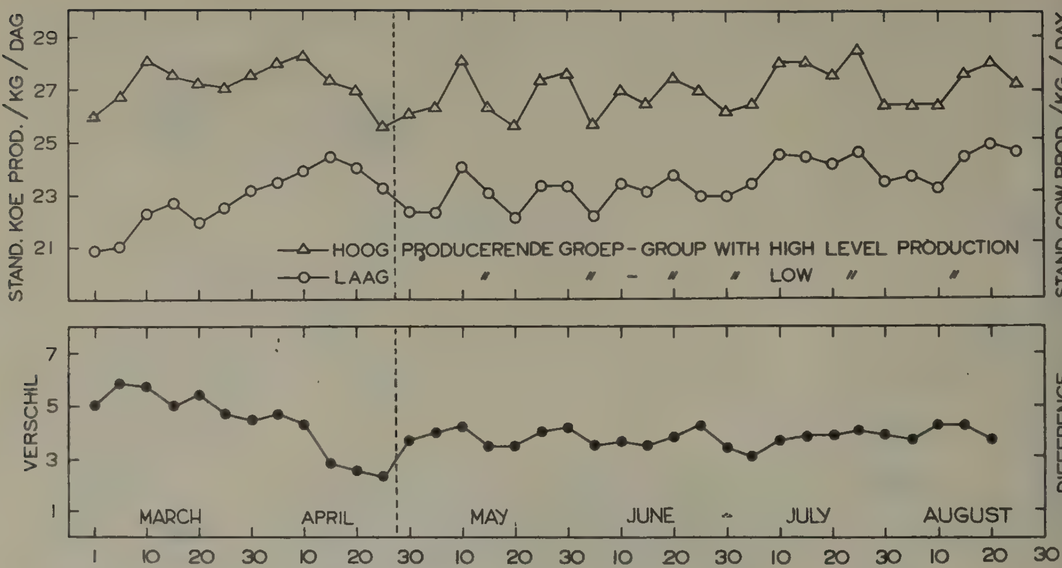

Fig. 7. The standard cow production of a group cows with a high level production, a group with a low level production and the difference between the groups, during some months of 1950 for a Friesian farm. Two groups of 9 cows were used. The real production of the group with a high level production averaged at the beginning of March 24.3 kg milk/day, the group with a low level 12.4 kg milk/day. The broken line indicates the time the cows went into the pasture..

Section D : World literature

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Section D: World literature*

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PART IV

HUMAN BIOCLIMATOLOGY

(1959)

Section A : Physiological bioclimatology

1. General physiological bioclimatology
2. Geographical bioclimatology
3. Ethnological bioclimatology
4. Acclimatisation bioclimatology

A CONTRIBUTION TO THE PHYSIOLOGY OF DAMP COLD AN ASPECT OF TEMPERATE CLIMATE

by

Dr. E.T. Renbourn (Great Britain)*

PART I THE CHILLS OF A DAMP COLD CLIMATE AN HISTORICAL SURVEY

by

Dr. E.T. Renbourn (Great Britain)

1. EARLY PERIODS TO THE END OF THE 17th CENTURY

In earliest times it was widely accepted that the soul, the life principle and the intellect were, in some way, linked with air and breathing. It is hence not surprising that the early Greek philosophers took it for granted that atmospheric air, with its vapours and contents, flowed freely into and out of the body not only through the lungs but through invisible pores of the skin and internal organs. Such rhythmic breathing, known as insensible perspiration (Greek, "adelos diapnoe" - to breathe through invisibly) was believed to be brought about by the alternate contraction and relaxation of the heart and blood vessels. Great importance was attached to this pulsatile process, because not only did it allow the whole body to be thoroughly "aired" but the insensible excretory vapours (and "fuliginous" or sooty fumes produced in the burning of the "vital flame" of the heart) could be passed out of the body. (Ref. no. 1).

The Greeks believed that the human frame was composed of four primitive elements - Air, Earth, Fire and Water - which had the dual properties of hot and moist, cold and dry, hot and dry, and cold and moist respectively. These elements were, somehow, combined to produce the four bodily humours - Blood (hot and moist), Black Bile (cold and dry), Yellow Bile (hot and dry) and Phlegm (cold and moist). It is clear that such physical properties, elements and humours were not such as to be easily measured or even ascertained by the senses, and contradictory statements abound in the early literature.

The nature, constitution or temperament of people was, so it was said, due partly to the mixture of the four primary properties or humours they were born with, but also to the climate or weather in which they lived. In damp countries, said Hippocrates, the inhabitants have a humid, gross, flabby and squat habit of body, and are liable to rheumatism of the joints, sciatica and gout. It was this excess humidity of the body (partly derived from the moisture of the surrounding air) which, he said, produced the poorly visible joints and veins, gave roughness to the voice and made these people less prolific than their neighbours. In any case, he added, this was to be expected, for did not the men wear breeches and spend most of the time on horseback ? Children, it seems, were of a hot and moist constitution, but this became colder and drier as age advanced. (Ref. no. 2).

Aristotle showed in the "Meteorologica" that he was conversant with the simpler phenomena of climate and weather and the nature of clouds, rain and dew. His pupil, Theophrastus, laid down the rules of weather lore in the "Book of Signs". Theophrastus believed, as did Hippocrates, that moisture clogged the intellect of man. "Other living creatures are inferior in understanding", he said, "for they breathe air that comes from the earth and take moister nourishment. The same principle explains why children lack understanding; for they are extremely moist and, in consequence, air cannot make its way throughout the body but it is set apart in the breast leaving them sluggish and witless" (Ref. no. 3). On the matter of the most healthful air, Galen

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noted that "pure air is that which is not defiled by exhalations from pools and marshes or from a pit giving off harmful vapours. And harmful too is that which is contaminated from the putrefaction of animals and vegetables. But the diversity of air which arises from heat, cold, dryness and moisture is not the same to all people "but.. the best is that most opposite to the predominant quality" (Ref. no. 4). Thus, for the sanguine (hot and moist) individual a cold and dry climate was, apparently, the best; but cold and damp was clearly more fitted for those of a bilious or hot and dry constitution – who were easily moved to anger and to violence. These various ideas on weather, climate and on the temperament of man, were to continue, often without modification, through medieval periods, the renaissance and later centuries, to almost modern times.

Many Greeks and later Roman physicians of the so called Methodic Schools ascribed fevers, inflammations and other diseases, to blocking of the pores of the skin – itself arising, so said Galen, from the insensible perspiration being too much increased or too thick, to the pores being unduly contracted by unwanted cold, or clogged by an air too damp or too heavy. Thus it followed that an atmosphere both cold and damp was particularly dangerous to health. For, when the excretory vapours could not get out of the skin or lungs, the stagnating humours of the body became greatly increased in amount (plethora) and could be directed to other places, such as the brain, the bowels, the lungs or kidneys, and there give rise to disease.

John Cauis, describing the "Ephemera Brittanica" or "English Sweat" (1552) (Ref. no. 5), said that this arose from "takinge enfection from evill brethynge places, landynge muddy and rotte groundes .. burieng dede bodyes .. dong Hilles". He advised, "drying the moiste aier with fyres ... in houses .. or in that side of cities and houses that lieth towards the enfection".

It must have always been common observation that water cooled more than air at the same heat and that clouds hid the warmth of the sun. "That air is thick", said Robert Burton, "which is kept longer before it be warmed by the sun beams, and once heated like an oven will keep itself from cold". (Reference no. 6).

The old Greek and Roman ideas on the nature and pupose of the insensible perspiration of lungs and skin were resuscitated by Sanctorius at the beginning of the 17th century. (Ref. 1 and 7). By weighing the "matter of perspiration" (insensible perspiration – but for centuries called, plainly, "perspiration") under various conditions, he showed, apparently, that it was far more important than all the other "servile excretions" put together. Violent passions, a cold damp or foggy air, and the cold dews of the dawn were, he said, the common causes of closing up the skin pores, and, hence, inevitably led to fevers, rheumatism, inflammations and to most other ills of the flesh. He stressed that a damp air, with its contained contagious particles, was also able to get into the body through the pores of the skin, particularly when these were first dilated by hot weather or by violent exertion. "The heat of the sun", said Francis Bacon, "is much milder and gentler in degree than that of a fire. It is much more moist in quality, especially as it is transmitted through the air". (Ref. no. 8). The warmth of clothing, he suspected, was due to the air it contained, for, he said, "there is doubt as to whether the warmth of wool, skin, feathers and the like, is derived from slight inherent heat since they are animal excretions .. or merely from the confinement and separation of air. For all air appears to possess a certain degree of warmth when separated from the external atmosphere .. Heat, with regard to the human senses", he continued, "is various and relative, so that lukewarm appears hot if the hand be ice cold, and cold if the hand be hot". (ref. no. 8). This matter was, however, well known to the early Greeks, many of whom insisted that, in any case, the senses could be fallacious. Robert Boyle (1665) (ref. no. 9) appreciated convection as a source of heat loss; and, a wind, he said, "by its motion is able not only to drive away the air contiguous to the hands and face and the warm steams of the body which tempered its coldness, but to pierce deeper than the calm air is wont into the pores of the body". "Cold naturally stops the pores", added Nicholas Culpeper, "congeals the humours, stops sweate, staies motion, and by this so stops the power of the spirits that it consumes the strength of the head and bowel". (ref. no. 10).

2. THE CHILL OF DAMP COLD. 18th CENTURY

In his book on the so called "Non Naturals" (1707) (ref. no. 11), Jeremiah Wainewright gave some thirty pages to the subject of the physics of the air and its effects on the body. "The Fens of Cambridgeshire", he wrote, "fill the Air with Vapours, whereby its Elasticity is weaken'd, the Fibres becoming relax'd and the Pores of the Skin obstructed. Now, if Coldness be added to the Moisture of the Air it will with so much more certainly produce these Distempers.... for Cold contracts and binds up, makes the Blood more compact, so that its Motion becomes slower and the Viscidity greater". Not only was damp cold a question of weather and climate but also of the night time; for, even in warm weather, cold and so called treacherous dews were often present before dawn. Wainewright ascribed consumption to "a fenny, heavy and smoaky air", but

it was to take almost two centuries to realise that the cold "Vapours" of the Fens, and the "Distempers" they produced, arose from the malarial ("mal-aria") mosquito and the parasite transmitted in its bite.

John Arbuthnot (1733) elaborated even more on the effects of the atmosphere. "Moist air", he stressed, "relaxeth the human Frame by weakening the Spring of the Air, and Moisture helps Air to insinuate itself into the Pores of human Bodies and to increase its Dimensions; and perhaps a due quantity of it is necessary for a right State of the Fluids and Solids ... It is very possible that human Bodies absorb Water from moist Air as fixt, dry, alkaline Salts do .. and many sudden changes may happen by absorbing the outward Air and all its Qualities and Contents. Nothing accounts so clearly for epidemical Diseases seizing human Creatures.." (ref. no. 12).

Senac (1749), the French physician, wrote more clearly on the effects of a damp cold climate. "When air is both humid and cold", he wrote, "it produces a more intense impression than when dry, for water is of a greater density and hence robs the body of more heat. It may, besides, be impregnated with various corpuscles which can, for example, seize on the lungs".(ref. no. 13). Another Frenchman, Sauvages, in his "Dissertation on Air" (1753), added: "Most vapours which are harmful to man are burning or stinking and extinguish the activity of the electric fluid, for... moisture destroys electricity".(Ref. no 14). Such ideas on damp air and electricity were to be met with periodically in the literature. Reminiscing on the campaigns of 1742 - 1750, John Pringle, Surgeon-General to the British Army, noted that "the evenings growing cool, night fogs, occasioning a stoppage of perspiration (viz. insensible perspiration), brought on the dysentery" (Ref. no. 15). Naval surgeons of the time, although aware of the real cause of scurvy, nevertheless insisted that an important contributory factor was the obstructed "perspiration" arising from the effects of "noxious" land breezes" and the "damp cold air from the sea". John Chandler (1761) (Ref. no. 16) enjoined, most stringently (as did Pringle, Count de Sax and others), the use of waistcoats or flanel belts (Ref. no. 17) for maintaining the flow of insensible perspiration in the face of the dews and chills of the night. He realised that there were other factors than air concerned in health and comfort, for a changing barometer could also stop the flow of cutaneous vapours. Of itself, a falling barometer had, he said. "a considerable effect on the organ of feeling, and changes the state of our bodies from easy to disagreeable sensations..... in a manner similar to that when we retire from the sun's rays into the shade". (Ref. no. 16). "It is incumbent upon the learned", wrote Tissot in 1768, "to choose as much as possible a temperate place and dry air. These are beneficial to the lungs, encourage the circulation and strengthen the fibres. Cold and dry air is tolerable, but a cold and damp air is very dangerous; it increased the disorders incident to Men of Letters, relaxes, obstructs the insensible perspiration, and produces catarrhs, rheumatisms and palsies". (Ref. no. 18). The moisture of the air was assumed to produce its effects by either mechanically obstructing the exit of cutaneous vapours through the skin pores or by stimulating the so called "absorbent" vessels (or lymphatics) of the skin. Some believed that moisture somehow "debilitated" the cutaneous blood vessels, thus impairing the natural force which expelled the insensible perspiration through their walls.

Even at this period there was already controversy as to whether wool was the best material to protect the body from cold and damp. Colombier, French army surgeon, was in doubt for, said he, wool "easily retains miasms floating in the air, dries with difficulty and finally imbibes sweat which then corrupts and gives out putrid and dangerous odours". (Ref. no. 19). Gilbert Blane (1785) argued, further, that wool was to be regarded as a sort of filter "to separate off the impurities of the air before it comes in contact with the surface of the body, and, therefore, any unreasonable change of apparel may be very unsafe to health". (Ref. no. 20).

Edward Rigby (1785) put forward the idea, expressed by Senac, that dry air is a good thermal insulator. Elaborating on the matter, he noted: "moist air is likewise a better conductor of heat than when dry, because water, though of the same temperature of the air, is well known to carry it off more quickly than air will do. If, therefore, these two causes (viz. cold and damp) unite, as in the case of moist and windy weather, we may easily understand why the heat of animals should be carried off more quickly and the animal experience a greater sense of cold than when the air is still and dry though the thermometer should, in both cases, stand at the same point". (Ref. no. 21). About this period, Count Rumford apparently proved the matter by his experiments on heated metal cylinders (covered with various cloths) allowed to cool under a variety of conditions. (Ref. no. 22). He also demonstrated the truth of the matter vexing Francis Bacon - that the warmth of natural materials is due, in great part, to the air they contain.

Writing at the end of the century in his popular "Family Medicine", Willich pointed out that "cold renders bodies more compact, particularly the solid parts of the animal structure such as muscles, nerves and bones; they become more elastic in winter. Damp or moist air suddenly relaxes and ennervates, occasions a slowing of the fluids which gives rise to obstructions and impedes both the circulation and secretion of the humours by choking the insensible perspiration". If, said he, "the moisture of the air increases, we experience an uncomfortable torpor or ennui; with the loss of energy we lose our gaiety and the mind is depressed as well as the body. Damp

places and districts are always unwholesome but more particularly so in cold weather...... (Ref. no. 23). Like Senac and others, Willich believed the effects of weather were in some way related to electricity. This, he said, "supplies the fibres with their natural tone, stimulates the vessels to a more vigorous action and increases the serenity of mind. This principle does not exist in the atmosphere of all places in equal quantity .. nor is it so at different seasons or at all times of the day. All men do not inhale this electric matter in equal quantities, and the remarkable differences in temperament are thus produced". (Ref. no. 23). Such an argument can be found even in modern books of medical climatology; nevertheless, much of it is reminiscent of Galen and Hippocrates. In the same year, Hufeland, discussing means of prolonging life, gave his opinion on weather and climate. "Air which contains a fine moisture", he noted, "is best for attaining great age .. for moist air, by being already saturated, has less attraction over bodies, that is to say, consumes them less. Besides, in a moist air, there is almost a greater uniformity of temperature .... Lastly it keeps the organs longer pliable and youthful. A striking proof of this is afforded by Islands ... which have at all times been, and still are, the cradles of old age". (Ref. no. 24). Here we have an argument in favour of a damp environment, but its logic is, again, reminiscent of earlier periods. Most of the remarks made during the 18th century on damp cold were, in great part, of a subjective nature. Physicians were, however, aware of the known meteorological instruments and occasionally made use of them with fair success. Louis Cotte, in his "Treatise on Meteorology" (Ref. no. 25), gave a chapter on Medical Climatology and discussed the importance of air pressure, humidity, temperature and wind on health and disease; but there was little outstanding to note. John Quincy, writing on hygroscopes in his "Medical Dictionary" of 1794, said: "How far the earliest notices of changes of this kind may be made use of by a physician, the skilful alone can judge". (Ref. no. 26). It is doubtful whether such measurements were often made during damp cold weather.

3. PHYSIOLOGY OF THE DAMP COLD PHENOMENON EARLY 19th CENTURY

Bichat (1802), the French anatomist, was amazed that animals could, apparently, take up so much atmospheric humidity into the body and, he added, "during a fog of twenty four hours duration, thrushes or red breasts are reported to become so fat that they are unable to fly from the sportsman". (Ref. no. 27). William Buchan, in his long popular "Domestic Medicine" (1807), continued the old ideas. "Very cold air obstructs the perspiration, constringes the solids and condenses the fluids. It occasions rheumatisms, coughs and catarrh, with diseases of the throat and breast. Air that is moist destroys the elasticity or springs of solids, induces a phlegmatic and lax disposition and disposes the body to agues or intermittent fevers" (Ref. no. 28). Such diseases, said he, were frequent in Holland, the Fens of Cambridgeshire and the Hundreds of Essex, but their real cause has already been suggested.

When, in 1824, William Edwards, French physiologist (Ref. no. 29), showed experimentally that, in man and animals, the amount of insensible perspiration was much greater in a dry than damp atmosphere of the same heat, he appeared to have confirmed the old belief that damp air clogged the "exhalent vessels" and skin pores. He also demonstrated, apparently, that a cold damp air did not, however, chill the body more than a dry one at the same temperature. This he explained by the fact that although damp air was a better thermal conductor, it simultaneously inhibited insensible perspiration and, thus, decreased both evaporation and heat loss from the body. This confutation of the long accepted belief in the chilling effect of damp cold was, nevertheless, to pass almost unnoticed.

Describing his experiences in the disastrous Russian Campaign of 1812, Moricheau Beaupré (1826) (Ref. no. 30), army surgeon, wrote on the effect of cold on the French soldiers. He divided cold into "real" and "sensible", the former representing that of the environment, and the latter the sensations (which could be modified by the "nervous power") felt by the body. "Real" cold was, he said, of a dry or damp nature. In dry cold the atmospheric temperature fell to freezing point or below, the air was contracted and its water vapour greatly diminished. Hence, he argued, its oxygen must be greater; and since, furthermore, the insensible perspiration of the lungs was increased (that of the skin being decreased), respiration was enhanced and the whole body stimulated to greater activity. The real danger of dry cold to the campaigning soldier lay in the absence of good food, the insufficient rest and the lack of available warm shelter. "Dry cold", he continued, "is a sign of a durable or little variable atmospheric state; no evaporation from the ground occurs, the heavens are serene, the air light, cheery, pure and clear; this condition is salutary to man. Humid cold is characterised by a less depression of temperature but the air holds much aqueous vapour. The humid state is noxious and is the most dangerous enemy of the animal economy; it produces effects altogether opposed to the former. Of this we are convinced by comparison of an inhabitant of a humid country with one of a dry cold; the one

is dull, bloated and phlegmatic, the other robust, nimble and active. Those of a sanguine or bilious nature are less chilled than those of a nervous or lymphatic temperament". Beaupré was well aware that the difference between dry and damp cold was one of weather and climate and not simply of air humidity alone; but he failed to stress the importance of barometric pressure, the sun and wind. There was, in fact, little objective basis for any of his arguments, many of which can be traced to Sanctorius, Galen and Hippocrates.

The existing ideas on the effect of a humid air were bedevilled by John Stark who, in 1833 (Ref. no. 31), believed he had proved that dark colours (and clothing) were more capable of absorbing odours, and hence (so others reasoned) humid air and its miasms. Andrew Combe, (1837), (Ref. no. 32) renowned hygienist of his time, went back a century or more in some of his arguments. "A moist air diminishes evaporation from the skin", he said, "partially shutting up the natural outlet of the superfluous heat of the body; and as it, at the same time, checks the exit of waste matters which ought to be thrown out, and which are known to be injurious to the system as an active poison, the hurtful consequences of such weather and climate, and the fevers, dysenteries and colds to which it gives rise, are partially accounted by it... A moist state of the atmosphere is also favourable to absorption, and hence if noxious effluvia are at the time floating in air, they are more easily received into the system. It is on this account that night air is so unwholesome, particularly in malaria districts which are loaded with moisture and miasmata or marsh poison; for where the air is dry as well as hot, free evaporation takes place and absorption is null".

Having reviewed the earlier literature, William Carpenter (1855) (Ref. no. 33) came to the conclusion that considerable amounts of atmospheric vapour must be absorbed into the human body. He went even further than Bichat and instanced the case of two jockeys who, within an hour or so of a race, became overweight by several pounds under conditions where such vapour absorption could be the only possible explanation. Such was the credulity of the physiologist a century ago ! Much was known, he continued, of the adverse effect of damp air at high temperatures, but "accurate experiments are yet wanting to determine the influence of humidity of cold air....... The depressing influence of cold with moisture, the existence of which is a matter of ordinary experience, is probably exerted directly upon the nervous system". Carpenter was well aware of the work of Edwards but doubted the accuracy of the latter's experiments on the effects of damp cold.

Ranald Martin (1856) (Ref. no. 34) had his own ideas as to the casual factors of agues and intermittent fever. "Electricity", he noted, "may be concerned with the generation of malaria, whatever its nature. A low state of electric tension causes obstruction of the nervous power and produces ennervation of the capillary system and an inverted condition of the bowels. Humid air, at an equal or superior temperature, produces a peculiar sensation of cold which differs not only in its intensity but in its nature. It is more profoundly felt, and seems to penetrate the whole system, and predisposes particularly to paleness and shivering. In dry air, on the contrary, a sensation is experienced which is called sharp cold... and an increase in activity is experienced... Damp cold must tend to produce, in individuals whose power of developing heat is rather feeble, the series of actions which constitute the accession of an intermittent fever, particularly if exposed to that action during sleep. The chief effect of moist air is exerted on evaporation from lungs and skin".

In 1858, Coulier (Ref. no. 35), professor of Military Chemistry at Vale de Grace in France, repeated Rumford's work on heat loss from fabric coated heated cylinders. The results led him to conclude that there were two levels of water equilibria in garment fabrics when worn; that arising from water vapour (from skin within and humid air from without) condensed in the fibre- "l'eau hygrometrique" - with liberation of latent heat, and that due to deposition of liquid water in the fabric interstices (from rain or sweat) with displacement of air - "l'eau d'interposition". This appears to be the beginning of interest in what is now called "sorption heat" of textile fibres, a property which may, itself, shed some light on the physiology of the damp cold phenomenon. Moore (1862) (Ref. no. 36), like Blane before him, argued that clothes could act as a filter of miasms, for, he said, "there are facts tending to prove that the body well wrapped in flannel, or clad in warm clothing, so as to prevent a check to perspiration and chill from the night air, is more capable of resisting malaria and inflammation of the liver and kidney". Edmund Parkes (1866) (Ref. no. 37), Professor of Hygiene at the Army Medical School in England, referred to the earlier work of Lehmann, on birds and rabbits, which suggested that more carbonic acid was exhaled from the lungs in a moist than in a dry atmosphere; but he was not prepared to say whether this was physiologically good or harmful. As for malaria, since this, he said, entered the body through the lungs or stomach, he could not agree with Moore as to the particular value of flannel in its prevention.

4. PHYSIOLOGY OF THE DAMP COLD PHENOMENON LATE 19th CENTURY

John Parkin, writing in 1882 (Ref. no. 38) on the relationship of climate and weather to phthisis, was naturally concerned with the effects of cold damp conditions. Although his arguments were not always consistent, he also concluded that cold damp was not necessarily more chilling than cold dry weather and, therefore, not particularly harmful. "Its is well known", he said, "that a damp or moist air generally feels colder than a dry one - temperature and all other circumstances being the same. The reason is that a damp air is a better conductor of heat than a dry one, particularly when accompanied by a strong wind. But no such effect is produced when there is calm or with a fog which has a tendency to check radiation from the surface. Hence it is that a moist atmosphere is frequently close and muggy, or, in other words, warmer than a dry one. On the other hand, a cold dry air may allow a much greater radiation of heat from the surface than a cold humid one, especially when accompanied by wind. Fogs and moisture may, therefore, prove beneficial, rather than otherwise, under certain circumstances and in cold latitudes. These impressions are confirmed by the fact that a dry and warm climate, so far from proving beneficial or acting as a preventative of phthisis, would seem to produce the opposite effect. This is the case of the South of France, or of Provence and Languedoc". (Ref. no. 38). Giving mountain resorts as an example, Parkin stressed the remarkable heating effect of a winter's sun under freezing conditions. He criticised other students of medical climatology (amongst whom he should, perhaps, be included) who "ascribed effects to causes recognisable to their senses, rather than to those deduced from strict analysis of all the phenomena". Parkin's suggestions concerning the effects of moist air on the radiation from the human body (based no doubt on the work of Tyndall), on the warmth of sunlight and the effect of wind, are aspects of the cold damp phenomenon to which sufficient thought has not yet been given. In spite of this illumination thrown on the subject, Thomson (Ref. no. 39), in the same year, went back half a century or more in his arguments, for, he said, "damp and moisture is one of the most prolific and most generally acknowledged source of disease in whatever way it is applied to the body; whether in the atmosphere, or the bed, it is alike apt to be productive of bad consequence and often of the most serious character. When combined with decaying vegetable matter, and more especially when increased by heat, fever and agues are the result; when cold and damp unite their depressing influences, colds of every kind, influenza, scrofula and consumption, rheumatism and neuralgia ensue... The chief evils to be dreaded are the cold winds which come off the water laden with vapour and which are liable to produce croup in children and catarrhal affection in the predisposed". (Ref. no. 39). Gustav Jäger (Ref. no. 40) (the originator of "sanitary" Jaeger wool) insisted that wool must be worn from head to toe, for not only did it absorb harmful damp effluvia of the air, but also a volatile "noxious" agent liberated in the insensible excretions of the body (especially after severe and unpleasant emotions!). Following Stark he insisted that dark coloured wool was far the best for removing such harmful matters (but light colours could be acceptable in the summer).

On the subject of damp cold, scientific enlightenment and return to the humoral theories of Galen and Hippocrates alternated to the very end of the 19th century. Even as late as 1897, Quain's "Dictionary of Medicine" (Ref. no. 41) written and revised for the expert, refused to accept the existence of "le microbe du paludisme" of Laveran as the cause of malaria. As for the vector mosquito, this was not even mentioned. On the other hand it was still seriously entertained that this disease was "the product of moisture ... and of vegetable decomposition". Before the beginning of the new century, Rubner and von Lewschen (Ref. no. 42), using a careful technique, confirmed the finding of Edwards that a high air humidity lessened evaporative cooling of the body by decreasing the amount of insensible perspiration.

5. CONCLUSION

The fear of cold and damp probably arose with the ancient Greek concept of insensible perspiration and the belief that atmospheric air, with its water vapour and effluvia, could pass into the body through the pores of the skin. For centuries, so called logical arguments, subjective and personal impressions and co-incidental factors, were interpreted as representing objective truths. Because he used a balance in his experiments, Sanctorius gave a stamp of authority to the dogma that obstruction to the "matter of perspiration", by cold or damp, was the cause of the discomforts and most of the diseases of the flesh. Such dogma was to remain till almost the end of the last century. There is no doubt, however, that malnutrition, bad hygiene, infection and other non climatic factors have played their role in the colds, the pneumonias, consumption, rheumatism, scurvy, dysentery and other diseases, which for centuries were ascribed to the humid cold of the atmosphere.

In the past, damp cold and its effects was mainly the concern of physicians who wrote lengthily on the matter but rarely measured or even adequately defined it. Not all however, were afraid of the dire consequences. Hufeland was convinced that one lived longer in a damp air, Edwards failed to prove its peculiar chilling qualities and Parkin advised consumptives to remain in the cold damp of England.

The expression damp cold is used nowadays more often by the layman, but it is still assumed by the more discerning that damp air is a better heat conductor and convector than dry air. However, modern workers have shown that there is, in fact, little difference in thermal insulation of moist and dry air and that convective heat loss in such atmospheres is almost the same. Little scientific work has yet been done on the matter of the cold damp phenomenon and this receives but scant attention in the texts of physiological or medical climatology.

More than two centuries ago it was suspected that the effects of a temperate winter involves a problem much wider than that of the physical properties of humid air (indoors or without) or even its effects on clothing and the skin. The solution to the problem may, perhaps, lie in the change of heat or of the water balance of the body resulting from the complex interacting factors of climate or weather. Psychological factors may play a part. Here lies work for the future. The first step consists, however, in defining what is meant by the loose expressions - damp cold and dry cold.

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PART II AN INVESTIGATION ON CLOTHED MEN UNDER INDOOR CONDITIONS

by

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1. INTRODUCTION

The expression damp, humid or moist cold is used in a variety of ways. It may refer to the environment of habitation or to the climate and weather conditions arising during the winter in maritime temperature zones. The adjectives may refer to a high relative humidity, to the presence of precipitation - rain, sleet and damp snow - or to presence of wet conditions underfoot (wet cold).

Dry cold, on the other hand, has similarly not been adequately described. Meteorologists and climatic physiologists normally use the term to mean freezing weather conditions with frost or snow on the ground. However, owing to variability of weather, a wet cold day may be followed by a dry cold night. Even under freezing conditions, snow may change from being dry and powdery to a clinging dust which melts into clothing when either the ambient temperature rises or with warm conditions in a tent etc. In the same way, vapour saturated air may be breathed into a sleeping bag and condense; and, with heavy exertion, sweat will accumulate in the clothing from within, to evaporate (or wick), condense and freeze in the outer layers. Although under freezing conditions the atmospheric air contains very little moisture (at most about 4 mm Hg partial pressure) the relative humidity out of doors is itself very high, but usually very low in habitation, particularly if this is warm by American standards. Relative humidity under freezing conditions is a rather meaningless term - humidity is better expressed as absolute humidity in terms of vapour pressure.

"Dry cold" is also used popularly for a hypothetical weather condition corresponding in temperature to "damp cold" weather (sun, cloud, wind, barometric pressure, etc. usually being unspecified) but with low humidity. In point of fact, at temperatures between 32°F and 48°F, a relative humidity below about 40% does not often occur in nature. The greater chilling effect of damp cold is generally explained on the assumption that dry air is a better thermal insulator than damp air. The historical development of this idea has already been outlined. As pointed out recently by Guillemin (ref. no. 7) and by Burton (ref. no. 4), there is, in fact, no great difference in thermal insulation between dry and very humid air. Guillemin (ref. no. 7) also points out that convective cooling by dry and humid air at moderate speeds of flow (proportional to square root of heat conductivity x specific heat x density) is also not very different. It must, hence, be accepted that under still air or at moderate wind speeds, the purely physical effect of dry or damp cold air will not be very different. Woodcock (ref. no.15) has recently given an excellent review of the theoretical relationships, near freezing point, of vapour and liquid water in air, through clothing layers and at the skin level.

Although there is no great factual evidence on the matter, what is popularly called "damp cold" weather may be associated with the interacting variables of a weather front - of a falling barometer and changing air temperature (say between 35-50°F), of generalised clouds and increased electrical state of the atmosphere, the presence of gusty winds and the likelihood of rain. "Dry cold" weather, on the other hand, may occur with a rising barometer, a stable and lower temperature, clear skies, little wind and bright sunlight. The feeling of "dry cold", in suitably dressed individuals, is related peculiarly to the extremities - hands and feet. That many people feel colder "all over", miserable and less active under so called cold humid weather, is undoubtedly true.

Apart from air movement and temperature, the independent physiological effects of any one meteorological condition are insufficiently understood. It has been assumed by some (ref. nos. 9 , 11) that the factors constituting a weather front may, in some way yet unknown, have an effect on the higher nervous centres (with resulting changes in pulse rate, blood pressure, blood cells etc.); and a state of tissue water retention could, conceivably, explain many of the clinical phenomena (aching corns, rheumatic pains, headache, generalised skin discomfort) associated with the body acting as a "cosmic resonator" (ref. no.11). Bright colours and a clear sky produce, in some individuals, a "feeling" of warmth. Perhaps, in the absence of sun, the presence of cloud and the thought of impending rain may, in a similar way, induce a "feeling" of cold or of damp. Much has been written on the effects of weather and climate on man, but how far some of the above phenomena are primarily psychological is not known.

Even under freezing conditions, solar radiation has an appreciable warming effect - both physiological and psychological. Clouds absorb the earth's long waves even more efficiently than the

solar short infra red radiation, but the effect of cloud cover on radiation heat loss from the clothed body (a matter considered some seventy years ago) is, however, likely to be negligible. Although, at low temperature, relative humidity of the air is not an important physical factor in convective heat loss, winds occur more commonly under so called "damp cold" weather conditions. Heat loss will also occur by rain impinging on the clothing, and, if absorbed, impairing its thermal insulation. It is now generally recognised that, under physical conditions, textile materials absorb water vapour with the liberation of appreciabel quantities of heat (ref. nos. 1 , 10); but little work has yet been done on the value of such "sorption" heat to the individual wearing wool in the form of garments.

A somewhat neglected factor in the problem of thermal comfort in cold weather, is that of shelter. In America, Canada and certain parts of Europe, a large proportion of the population live in winter under much warmer and drier indoor conditions (about 75-80°F and 25-30% R.H.) than those in England (about 60-65°F and a higher humidity), even with similar weather conditions. In the former countries, individuals put on warm dry clothing in the mornings over the already warm skin. Such conditioning may, perhaps, make them temporarily immune to the effects of cold weather whether damp or dry.

This report is concerned with the effects, under indoor conditions, of moderately low and high humidity at a low air temperature (36°F) and the modifying influence of warm and cool housing environments.

2. EXPERIMENTAL METHOD

EXPERIMENTAL CONDITIONS

Groups of men were conditioned to indoor environments corresponding, more or less, to those of an average "American" and "British" house during winter months, and then exposed to two indoor cold environments of the same temperature, air movement and radiation characteristics, but of different humidity. By choice, a temperature of 60°F would have been adopted for the "British" and 75°F for "American" conditions. However, owing to a sudden mild spell of weather during the period of the trial, and the difficulty experienced in maintaining a temperature of 60°F in the simple hot chamber available, it was decided to adopt a temperature of 65°F. In order to maintain a reasonable difference between the conditioning temperature, the "American" environment was raised to 80°F. The mean relative humidities of the two environments were "American" 37 % and "British" 58%. The cold environment was produced in a chamber whose entry was within a few feet of that of the hot chamber. An average air temperature of 36°F was maintained. Technical difficulty was experienced in maintaining a constant relative humidity in the type of chamber in use, and the average conditions that could be maintained were 50% R.H. ("moderate humidity") and 85% ("high humidity"). Whilst the levels and constancy of humidity were not that desired, it is considered that the difference between the relative humidity does correspond to that likely to occur in nature at a temperature of 36°F and was sufficiently wide to serve as basis for preliminary investigation. In all cases the air movement was minimal (15 ft/min.). The effect of slight variability in air movement in different parts of the chambers was minimised by men occupying the same positions during all exposures. Wall temperature in the chambers was at air-temperature. Since it is possible that weather conditions to which men are exposed may conceivably affect the experimental results, the conditions out-of-doors, in the building housing the climatic chambers, and in the conditioning and cold environments, are given in Table 1 below:

TABLE 1 - ENVIRONMENTAL CONDITIONS

ENVIRONMENT		A.M.		P.M.	
		Temp. °F	R.H. %	Temp. °F	R.H. %
OUTSIDE:	Mean	50	78	57	69
	Range	42 - 59	52 - 100	52 - 67	33 -100
IN BUILDINGS:	Mean	57	59	63	50
	Range	53 - 64	42 - 83	56 - 67	30 - 69
CONDITIONING ENVIRONMENT:					
(A) "American":	Mean	79.4	37	79.4	41
	Range	75 - 81	35 - 42	78 - 80	38 - 44
(B) "British" :	Mean	65.7	58	66	58
	Range	64 - 69	55 - 66	65 - 70	53 - 70
COLD ENVIRONMENTS:					
(X) "Dry" :	Mean	36.3	47	36.8	53
	Range	35.3 - 37.0	42 - 55	35.5 - 38.3	43 - 58
(Y) "Damp" :	Mean	36.3	87	37.1	85
	Range	35.5 - 37.2	75 - 94	36.8 - 37.7	79 - 91

DESIGN AND ANALYSIS

The basic design of experiment consisted of a 4 x 4 Latin Square (see below) which allowed different orders of conditions to be balanced. On each morning, for 4 mornings of a week (Tuesday to Friday), a group of 4 subjects was used for the measurement of body temperature, clothing humidity and temperature gradients (three men only), and of subjective data. This was done for a total of 4 weeks (total 16 men). In the afternoons, another group of 4 men was used for nude body weight loss, respiratory ventilation volume measurement and subjective data. Over a 3 week period this gave a total of 12 men (with grand total of 28 men for subjective data).

DESIGNED BLOCK

Week	Day / Subject	Tuesday	Wednesday	Thursday	Friday	
1 AM PM	1 - 4 1a - 4a	BX	AX	BY	AY	ENVIRONMENTS A = "American"
2 AM PM	5 - 8 5a - 8a	AX	AY	BX	BY	B = "British"
3 AM PM	9 - 12 9a - 12a	AY	BY	AX	BX	X = Moderate RH cold
4 AM PM	13 - 16	BY	BX	AY	AX	Y = High RH cold

Groups of men were available for a period consisting of one preliminary day and four experimental days - the shortest period within which the subjects could experience all the environmental combinations. The object of the short period was to minimise the possible effects of outside weather and living conditions on the men. The first day of each week was used as an indoctrination period, during which men were exposed to the environmental combination of the first experimental day. Measurements were not taken, but subjects were able to become acquainted with the apparatus and procedures for the objective and subjective measurements.

The design of the experiment was such that the effects of the two conditioning environments upon the objective measurements obtained in the two cold exposures, and the effects of the latter alone, could be separately analysed. Means of AX, AY, BX, BY are all directly comparable. Overall means for comparison of the two conditioning $\left\{A = \frac{AX + AY}{2}, B = \frac{BX + BY}{2}\right\}$ and the two cold environments $\left\{X = \frac{AX + BX}{2}, Y = \frac{AY + BY}{2}\right\}$ are given in the tables and figures below.

Strictly speaking only the differences between A and B, and between X and Y means have a physical meaning and no valid comparison can be made for example between A and X means.

Separate χ^2 tests were carried out on the subjective data obtained at the beginning, middle and end of the sessions in the cold environments. Morning and afternoon data were summated as there was insufficient information for separate analyses. Data from the three periods during a session were not combined, as three opinions from one subject, during one session, cannot be considered as independent. Such combinations would treat the data as if 3 x 28 i.e. 84 subjects had been used - an obviously fallacious assumption. Subjective data taken after men left the cold chamber were also treated by χ^2 analysis.

EXPERIMENTAL PROCEDURE

Fit young men of age 19-24 years were used as experimental subjects. The following clothing was issued to the man (as it had been shown that when wearing them they could remain in the cold chamber for two hours without shivering or severe discomfort): woollen jacket and trousers, wool shirt, woollen vest and short woollen pants, woollen gloves and socks (total weight of garments $7\frac{1}{2}$ lbs); heavy boots. No headgear was worn.

In order to simulate, with the facilities available, the changes occurring with sleeping indoors, the clothing was exposed overnight to the conditioning environment for the next day. On arrival at the laboratory in the mornings subjects visited the toilet, walked into the conditioning environment, removed their own clotning, and were equipped with harness for rectal and skin temperatures. The conditioned clothing, with incorporated elements for temperature and humidity gradients, was then put on. Men then sat quietly on chairs on which they remained for the whole experimental session (conditioning and cold exposure). This minimised physiological

changes (viz. Body temperature etc.) due to movement and variation in posture. The maximum experimental period (sitting) that could be permitted in the conditioning environment was 45 minutes. Subjects were then carried into the cold environment, at 6 minutes intervals, where they remained seated for a period of 102 minutes (again the longest period available).

In the afternoons, men entered the conditioning environment as above, were weighed nude before dressing in the conditioned clothing, and then sat down. Respiratory ventilation volumes were measured halfway through conditioning and cold periods. After being carried back to the conditioning environment, subjects undressed and were re-weighed. Otherwise the procedure was as for the mornings. During the experimental periods men were allowed to read or converse, but no other activities (smoking etc.) were allowed.

MEASUREMENTS

OBJECTIVE

BODY TEMPERATURE

Skin temperature was measured with thermocouples (soldered to copper gauze buttons and strapped on to the skin so as to leave the junction freely exposed) at 5 points (chest, shoulder, upper arm, thigh and calf) under the clothing (see fig. 1). Because of the interest in the face as a possible "trigger" factor in cold phenomena, cheek temperature was also measured with a thermocouple applicator. Rectal temperature was measured 10 cm along a flexible thermocouple element kept in position by a simple harness. Skin temperature is conventionally measured "near" the skin (on top of hairs etc.), only a few selected sites can be investigated at a time, and area "weighting" may not be very accurate particularly when rapid changes of internal temperature are occurring. It was, hence, considered of no particular value, in the present study, to estimate average skin temperature of the "whole body". For similar reasons (viz. local variation etc. in rectal temperature, ref. no.14),"mean body temperature", "heat storage" and "tissue insulation" were not used in the comparisons.

TEMPERATURE AND RELATIVE HUMIDITY GRADIENTS BETWEEN CLOTHING LAYERS (see fig. 2 and 3)

Humidity sensing elements of lithium chloride impregnated polyvinyl alcohol films were used, with which a thermocouple was incorporated (ref. no.12). The chest was considered a suitable point for investigation. An element was attached to the skin (about 1/10" from the skin) 2" below the left nipple, a second attached to the outer surface of the vest and another to outer surface of the shirt. The three positions were slightly staggered in order not to distort the gradient artificially. Readings were taken every 6 minutes in the cold environment.

RESPIRATORY VENTILATION VOLUME

This was measured with the Wolff "Integrating Motor Pneumotachograph" (IMP). Such measurement was used as an index of metabolic rate, and in the context of the present experiment (same men, same activity) was considered of sufficient accuracy for comparative purposes (ref. no.5). Sampling periods of 15 minutes were used during the middle of the acclimatising and cold sessions.

NUDE WEIGHT LOSS

Subjects were weighed nude (with the usual precautions) on a man balance, of accuracy $\pm$ 5 gm, on first entering the conditioning environment and as soon as possible on return from the cold environment.

SUBJECTIVE

The object of the trial and the purpose of the subjective phase was explained to the subjects on the first day of the trial, and at no time were they aware of the environments to which they were to be exposed. No questions were asked in the conditioning environment. Immediately on entering the cold environment, they were presented with the following questionnaire on a card:

FACE – Does your face feel DRY OR MOIST ? WARM, COOL OR COLD ?

BODY – Does your body feel COMFORTABLE OR COLD? If comfortable, WARM OR COOL ?
If cold, COLD OR VERY COLD ?

FEET – Do your feet feel COMFORTABLE OR COLD ? If comfortable, WARM OR COOL ?
If cold, COLD, VERY COLD OR PAINFULLY COLD ?

In order not te be influenced by each other's results, subjects indicated their answer by a pointer. The whole questionnaire was presented again midway through the session and after its termination. Immediately on leaving the chamber, each subject was asked – "How did you feel in the cold chamber compared with yesterday ?"

3. RESULTS

OBJECTIVE DATA

All measurements for which variance analyses were made, showed, as expected a significant man to man variation - an individual type of response to temperature and to humidity exposure. Some of the man to man effects may, however, be due to other factors, viz. different positions in the chamber (see para.13). For none of the objective measurements was there a significant interaction between conditioning and cold environments i.e. the difference between the two conditioning environments could be considered the same for both "cold damp" and "cold dry" experimental environments.

EFFECT OF CONDITIONING ENVIRONMENTS ON COLD EXPOSURE

RECTAL AND SKIN TEMPERATURE

The mean initial and final rectal and skin temperatures are given in Table 2 below and the means taken every 24 minutes in Figures 4a and 5.

TABLE 2 - EFFECT OF CONDITIONING ENVIRONMENTS ON COLD EXPOSURE
(32 experiments per environment)

Part of the Body	Initial Body Temperature °F				Final Body Temperature °F			
	"British" Envir.	"American" Envir.	S.E. Diff.	Sig.	"British" Envir.	"American" Envir.	S.E. Diff.	Sig.
Rectal Temp.	99.1	99.2	0.40	Not Sig.	98.7	98.9	0.18	Not Sig.
Skin Temp.:								
Cheek	83.1	87.0	0.99	$P < 1\%$	70.7	71.0	1.22	" "
Chest	93.8	95.5	0.47	$P < 1\%$	91.9	91.4	0.41	" "
Shoulder	91.2	92.8	0.36	$P < 0.1\%$	89.1	88.8	0.61	" "
Upper Arm	88.7	91.2	0.38	$P < 0.1\%$	83.8	84.4	0.33	" "
Thigh	87.0	89.6	0.39	$P < 0.1\%$	81.5	82.1	0.54	" "
Calf	81.0	83.1	1.34	Not Sig.	73.5	73.8	0.76	" "

Although there was no significant difference either in initial or final rectal temperature between the effects of the conditioning environments, it is to be noted that in both cases there was a mean rise of about half a degree between 6 and 30 minutes after entry into the cold, followed by a fall of about three quarters of a degree at 102 minutes. Differences between conditioning environments, either in rise or fall are, however, not significant. This point will be taken up later. Of the initial skin temperatures, all except that of the calf demonstrated significantly higher temperature for the warmer conditioning environment ("American"). As might be expected, the cheek (the only exposed skin site) showed the greatest mean difference (3.9°F). None of the skin temperatures taken after 102 minutes showed any significant differences - the warming effect on the skin had worn off.

TEMPERATURE GRADIENTS BETWEEN CLOTHING LAYERS

Owing to a number of "missing points" (due to difficulties in instrumentation) it was not possible to do a variance analysis of temperature gradients, but the means are shown in Figure 6a. It is seen that between each layer, considerable higher initial temperatures were obtained after conditioning at 80°F ("American") than after 65°F ("British"). Since the outer layers of clothing are in close contact with ambient temperature and temperature regulation occurs at the skin surface, it is to be expected, as was the case, the difference between the effects of the two conditioning environments, should be greater between shirt and battle dress tunic (7.3°F) and between vest and shirt (7.7°F) than between skin and vest (3.3°F). In contrast with the skin temperatures, it is seen that the difference in gradients, although reduced, persists throughout the period in the cold environment. It is not possible to attach levels of significance to these differences but, in comparison to the final skin temperature difference on the chest of 0.5°F, that between vest and shirt was 4.7°F and that between shirt and battledress 3.1°F.Since the conditioning environment differed in both temperature and humidity, it is not possible to separate these effects. Data from the humidity elements will be dealt with below.

RESPIRATORY VENTILATION VOLUME

The mean difference between the conditioning environments was "American" - "British" = 0.2 litres per man per minute, (S.E. = 0.62) not significant. One can assume that significant differences in the corresponding metabolic rates would not be present.

BODY WEIGHT LOSS

The mean weight loss per individual was 52 gm higher in the warmer environment, and, with S.E. = 9.8, this is highly significant ($P < 0.1\%$). The difference is due mainly to greater insensible perspiration (and, probably to light sweating) in the warmer environment. This result was expected.

EFFECT OF COLD ENVIRONMENTS

RECTAL AND SKIN TEMPERATURES

The means are shown in Figures 4b and 7 and the means of initial and final temperatures are given in Table 3 below:

TABLE 3 - EFFECT OF COLD ENVIRONMENTS
(32 experiments per environment)

Part of the Body	Initial Body Temperature °F				Final Body Temperature °F			
	High R.H.	Moderate R.H.	S.E. Diff.	Sig.	High R.H.	Moderate R.H.	S.E. Diff.	Sig.
Rectal Temp.	99.1	99.1	0.18	Not Sig.	99.0	98.7	0.18	Not Sig.
Skin Temp.:								
Cheek	85.2	84.9	0.99	" "	70.3	71.4	1.22	" "
Chest	95.2	94.1	0.47	$P < 5\%$	92.5	90.8	0.41	$P < 0.1\%$
Shoulder	92.5	91.5	0.36	$P \simeq 1\%$	89.3	88.6	0.32	Not Sig.
Upper Arm	90.1	89.7	0.53	Not Sig.	84.5	83.7	0.95	" "
Thigh	88.8	87.8	1.28	" "	82.0	81.6	0.52	" "
Calf	83.0	81.1	1.34	" "	73.2	74.1	0.76	" "

As in the case of the effect of the conditioning environments, there was no significant difference in initial or final rectal temperature between "cold damp" and "cold dry" environments. There was no significant difference between environments in rise or fall of temperature.

It is seen from figure 7 that skin temperatures of chest and shoulder had almost reached steady values at 102 minutes, whereas those of cheek and limbs had not. Of the initial skin temperatures, those of chest and shoulder were respectively 1.1°F ($P < 5\%$) and 1.0°F ($P < 1\%$) higher for the cold damp environment, but other sites showed no significant differences. Only the chest showed a significantly higher (1.7°F. $P < 0.1\%$) final skin temperature in the cold damp. However, the drop in chest skin temperature during exposure to "dry" cold was 3.3°F with a drop of 2.7°F in damp cold, a difference which is not significant. From the physiological point of view we therefore, treat these results (and those of shoulder temperature) with some reserve. One would have expected the cheek to show the greatest difference between cold environments, since this was the only part of the skin exposed (i.e. nude skin).

TEMPERATURE AND RELATIVE HUMIDITY GRADIENTS

Figure 6b shows that, in contrast with the marked difference associated with the conditioning environments, differences in clothing temperature gradients between cold environments were negligible and clearly not significant.

Earlier work (Ref. no.12) had indicated that the humidity elements used in this study showed promise for use near the skin and between clothing layers. In the present trial, however, their performance was disappointing. While it was not possible to draw quantitative conclusions from the data, the results gave the following strong indications:

a) under the same conditions there were marked differences between individuals;
b) no consistent differences were observed between either the conditioning or cold environments;
c) there was a marked fall in relative humidity at all positions, variable in rate and extent, on changing from the conditioning to the cold environments. This fall was contrary to first expectation, since the cooling of air in the layers of clothing, after entering the cold environments, would increase the relative humidity due to the water vapour already present.

This makes the assumption of still air conditions, but both the direction of the change in humidity, and its rapidity of onset, suggest a much brisker gaseous exchange between the surroundings and the clothing layers than was anticipated. Thus, the average vapour pressure of both conditioning environments was approximately 10 mm Hg, which (neglecting for the moment evaporation from the skin), on permeating to the layer between the skin and vest at a temperature of say 90°F, would give rise to a relative humidity of approximately 28%. In the cold environments, on the other hand, even at the high humidity, the vapour pressure was only about 4.6 mm, which at 90°F represents a relative humidity of 13%. This expected difference, based on the above figures, is of the same order as that actually found in the experiment.

While therefore, it was disappointing not to be able to obtain precise data on vapour pressure gradients under cold dry and damp conditions, the results indicate the presence of phenomena of real interest and the continuing need of a reliable method of measurement.

RESPIRATORY VENTILATION VOLUME

The mean differences in respiration ventilation volumes between high and moderate humidity was 0.8 litres per man per minute. With S.E. = 0.62 this is not significant. One may again assume no significant differences in corresponding metabolic rates.

BODY WEIGHT LOSS

The mean body weight loss per person between high and moderate humidity was 7 gm, and with S. E. = 9.8 this is not significant. It can be assumed that, in the cold, there is no significant difference in insensible perspiration loss between the moderate and high humidity. This is in contrast with the results obtained from the warm and cool conditioning environments.

SUBJECTIVE DATA

Replies to the questionnaire presented immediately on entering the cold environment showed no significant differences (χ^2 test) between any of the four combinations of conditioning and cold environments for face or feet. For the face, scores ranged from "warm" to "cold", but for the feet all were "warm" or "cool". Replies for the body were all "warm" or "cool" but there was a significantly greater proportion of "cool" replies ($P < 5\%$) in changing from the "British" conditioning to the moderate humidity than for the other three combinations, between which there was no difference. This is directly opposed to the popular impression of greater chilling in the damp. It is to be noted that the greater sensation of chilling in the cold at the moderate humidity, was present only when changing from the "British" and not from the "American" conditioning environment. The inference here is that in the latter case, any effect of humidity in the cold environment was masked by the reservoir of warmth acquired from the higher temperature of the "American" environment. There was no significant difference between any of the combinations of environment from the replies to the questionnaire put half way through the cold session. The range of replies was, however, extended to include some of "cold" and "very cold" for the body, and "cold" for the feet. With the final replies at the end of the cold session, there was no significant difference between any of the combinations of environment for the face or the body. With the feet, however, there were no differences between damp or dry cold, but in both of these the subjects were warmer after the "American" than after the "British" conditioning environment ($P < 2.5\%$). The replies for the feet extended from "warm" to "very cold", but none of the subjects was painfully cold.

It is worthy of note that no differences between any of the environments were found in sensation of the face. It was again thought that this, the only exposed site, might have been sensitive to difference in humidity immediately the subjects entered the chamber. In fact, however, the replies were very consistent throughout the session - 83 "dry", 28 "moist" at the beginning, and 85 "dry" and 27 "moist" at the end. It may be concluded that under the relative humidities and conditions of experiment, the subjects were not able to discriminate air of moderate or high humidity at a temperature of 36°F, the majority of replies for the face being "dry" for all conditions. It appeared, from the questionnaires taken after leaving the cold environments, that the opinions of thermal comfort, compared to that of the previous day, were more influenced by the conditioning than the cold environments.

4. D I S C U S S I O N

In the last four years, three papers have been published dealing with the cooling power of damp and dry air at temperatures below 60°F. To facilitate discussion, details of these are given below together with those of the present study.

TABLE 4 - ANALYSIS OF INVESTIGATIONS ON COLD DAMP PHENOMENON

	Authors			
	Guillemin 1954 (Ref. no. 7)	Burton et al 1956 (Ref. no. 4)	Iampietro et al 1958 (Ref. no. 8)	Renbourn et al 1958
Cooled object	Nude and clothed metal cylinder	nude men	Nude men	Clothed men
Treatment before cold exposure	-	Unspecified	"Comfortable" Temp. 60 min.	"British" and "American" Envir. 45 min.
Cold Envir. Temp.	40°F and 50°F	48°F and 58°F	50°F and 60°F	36°F
R.H.	15% and 85%	34% and 80%	30% and 95%	50% and 85%
V.P. mm Hg.		10.0	12.6	2.75 4.6
Wind	1 and 4 mph	0	1 and 10 mph	0
Time	40 min.	100 min.	120 min.	102 min.
Posture and Activity	-	Horizontal	Unspecified	Sitting
Measurements:				
Temperature;				
Surface	+	+	+	+
Deep	-	+	+	+
Clothing	-	0	0	+
(R.H.)	-	0	0	(+)
Metabolism	-	+	+	+
Nude wt. loss	-	0	0	+
Subjective	-	+	+	+
Total duration Experiment for any subject	-	Up to 3 months	8 days	4 days

-, not applicable; 0, not done; +, done; (+), done, unsuccessful.

Guillemin (Ref. no. 7) concluded that "for an inanimate test object simulating the thermal properties of a nude or clothed sedentary man, in windy or calm air, there is no significant difference in chilling effect between a dry cold and a moist cold environment". This agrees with the known physical properties of damp cold and dry cold air.

The other three papers are of a physiological nature and can be suitably dealt with together. Both Burton et al (Ref. no. 4) and Iampietro et al (Ref. no. 8) were concerned with the effect of humidity on nude men at temperatures of about 50° and 60°F; the present study deals with clothed men at a temperature near freezing point.

Design of experiment may be of some moment in laboratory experiments dealing with environmental factors, for, since men are ordinarily exposed during most of the day (and night) to uncontrolled indoor and variable outdoor weather conditions, this may, conceivably, modify their response during the shorter exposure to another environment, albeit in a controlled climatic chamber. The longer the total duration of such an experiment, the greater the probability of such extraneous source of variation. Such variation is minimised if groups of men (rather than individuals) are exposed together over the same short period of time. The size of a climatic chamber and the number of available men may, however, be critical factors. It has been shown that, after lying down in a constant environment, it may require $\frac{3}{4}$ - 3 hours before an apparent steady state of rectal temperature is reached (Ref. no.14). For this reason, as long as possible a period of equilibration should be allowed to minimise possible sources of error outlined above. Although gentle movement has little obvious effect on rectal temperature, a change from horizontal to the vertical may cause the internal temperature to rise within 5 minutes and to continue to rise (by 0.5 to 1.0°F) for half an hour or more (Ref. no.14). Furthermore, diurnal and other physiological variations of temperature may occur independently of an experiment (Ref. no.14). For these various reasons, in investigations where change of internal temperature is likely to be small, it may not be possible to draw valid conclusions from the results (even if highly significant statistically) unless adequate control of experiment be used.

Although 45 minutes of conditioning to the "American" and "British" indoor environments produced no significant difference between them in rectal temperature on subsequent cold exposure,

there was significantly higher skin temperature, at all points, in men who had been in the warmer environment. Such men also showed higher temperatures between clothing at chest level. After 102 minutes in the cold, when the skin effect had worn off, the between-clothing temperatures continued higher. These results suggest that people sleeping indoors at what corresponds to dry summer heat, and putting on warm dry clothing in the morning, will be less affected by outside cold air (whether of high or low humidity) than those coming from a cool ("British") habitation or shelter. It is not certain, however, that the pre-warmed individual retains a physiological advantage after a few hours cold exposure. Our results correspond to those derived from a motionless individual under still air conditions. Under variable activities out of doors, the period of greater warmth may be appreciably less than the two or so hours suggested by the experiments. Individuals habituated to a "hot-house" (by British standards) in the winter, appear to be those who particularly complain of being "chilled to the marrow" when living in a cool house and exposed to temperate winter conditions. It may well be that our American and Canadian colleagues, who live in towns (and have heated vehicles etc.) do not ordinarily feel the cold because they are not often, or for long, exposed to it.

In all the three above physiological studies, exposure to cold was associated by a variable rise followed by a fall of rectal temperature. In the case of Iampietro et al and of ourselves, no significant difference between rise or fall of temperature was due to humidity itself. However, at an ambient temperature of 48°F, Burton et al found no change at high humidity but a rise of rectal temperature at low humidity of 0.36°F after 50 minutes (P=15%), and of 0.56° F (P=7%) at 100 minutes exposure. This greater rise (but hardly significant) in dry cold was ascribed to vasoconstriction (as calculated) and the small increase in metabolic heat production.

Earlier work in this laboratory was not able to confirm a consistent "paradoxical deep temperature phenomenon" on hot or cold exposure (viz. early fall on entry into the heat followed by a rise, and vice versa), and one of us has unpublished data showing that mental "apprehension" may be associated with a fall in skin and a rise in oral temperature (of mean about 0.5°F). There seems to be some evidence for such a mental state being more associated with cold than with warm exposure in a climatic chamber. In the present experiments the cold chamber contained far more scientific "hardware", with periodic irritating noises due to thermocouple switching gear. For these various reasons, we prefer, at present, to treat the mechanism of the rise of rectal temperature in the cold with some reservation. It is of interest that there appears to be little "awareness" of an appreciable rise or fall of internal temperature. This phenomenon has been noted before (Ref. no.14).

Burton et al found no difference in skin temperature between high and low humidity in the cold except in the case of the chest which was 2.5°F higher (P=4%) at low humidity. Buettner (ref. no. 3) has shown that when atmospheric vapour pressure is above 21 mm Hg, water vapour passes into the skin ("negative" insensible perspiration). This may conceivably be associated with liberation of "sorption" heat. These facts were used by Burton et al (Ref. no 4) to support the following argument; "the paradox of a greater sensation of cold and metabolic response at low humidity, though skin temperatures and heat loss were independent of humidity, could be due to the uptake of moisture in the skin at high humidity.." However, the temperature of vapour saturated air at a partial pressure of 21 mm Hg is about 73°F. With the available data, there is as yet no clear evidence that under subjectively "cold" conditions (as used in the three investigations under consideration) a high relative humidity will, per se, diminish evaporative cooling because of vapour absorption by the skin. There is some controversy in the literature as to the effect of high humidity on insensible perspiration loss by clothed men under warm air conditions (70°F – 80°F) (Ref. nos. 2, 16) but the general consensus of opinion is that it is increased. Insensible perspiration appears to decrease with cold conditions but this is less marked in clothed men (Ref. no.10a). The effect of relative humidity at low temperature is, however, not known. Iampietro et al found no difference in skin temperature between high and low humidity, but mean skin temperatures of whole body and not individual skin temperatures were examined. In our own case, no significant differences were found except at chest and shoulder on early exposure, with a highly significant difference at the chest at the end of the exposure, the higher temperatures being found at the higher humidity. This result (which we nevertheless treat with reserve, see Results) is in contrast to the findings from the warm conditioning environment, where, early in exposure, most skin points (particularly that of the face) showed significantly higher temperatures. A higher skin temperature in damp cold is, in any case, not likely to be explained by a decreased evaporative cooling of the skin, for, in our data, no significant difference was found between insensible perspiration loss in the cold at high or the moderate humidity. The negligible effect of humidity on skin temperature in general fits in with the finding of no subjective difference in chilling.

If, at 40°F, the "sorption" heat of wool is associated with the marked rise of temperature (8-9°F) observed by Fourt (Ref. no. 6) (using a fabric assembly of wool serge and wool underwear), it might be anticipated that some of this would be noted in resting men, wearing three layers of wool, even with the smaller humidity change used in the present experiment. However, no difference in clothing temperature gradients between moderate and high humidity was found at

chest level (the only skin site to show any consistent change). It is unfortunate that gradients at other sites could not be measured, and it is regretted that we were not able to obtain data on vapour pressure at the skin level and between clothing. Even under resting conditions, convection currents pass out from the body, chimney ventilation passes up from the chest and bellows ventilation of the trunk (due to respiration) occurs some twenty times a minute. This may, perhaps, partly explain our lack of evidence for "sorption" heat of clothing under physiological conditions. Out of doors, the air movement arising from marching and that of wind is to be considered. Our present data are few and preliminary, and more detailed work on the physiological problem of "sorption" heat is to be carried out in this laboratory.

As anticipated, Iampietro et al found a marked cooling action of wind (presumably streamlined in a wind tunnel) on the nude body, but with no significant effect arising from the relative humidity of the moving air. Early work in our laboratory (on the comparison of wind resistant and wind permeable garments) (Ref. no.13) showed no differences in skin temperature arising from turbulent air in a climatic chamber at 10°F or with winds out of doors at 40°F-60°F, yet with highly significant differences at 60°F in streamlined air, of similar speeds, in a wind tunnel. Since natural winds are usually turbulent, results obtained in a wind tunnel may somewhat exaggerate their physiological importance in the clothed man under temperate conditions.

The only differences found by Iampietro et al between damp and dry cold was a greater metabolism for nude men (3/4 experiments) in the latter environment, but there was no associated subjective difference. Our own results, however, show no such significant metabolic difference for clothed men.

It may be concluded that for clothed (and probably nude) men, under conditions of moderate cold, few physiological differences of practical importance are present due to the air humidity itself. The myth of chills arising from cold damp air and the fear of "the cold dews of the night" can, perhaps, after many centuries, be laid down; and to this can be added the old but still prevalent belief that damp air is a better heat conductor and convector than dry air.

Problems of body heat regulation will always require controlled laboratory experiments for their elucidation. But it is to be remembered that a hot chamber is not the equivalent of a hot climate, either biologically, physiologically, psychologically or even meteorologically; the same is fully true for a cold chamber. If differences are found between results derived from physical models in a conditioned cubicle, from nude men resting in a climatic chamber and from active people out of doors, it must be conceded that such differences may, in part, be due to the fact that phenomena of increasing complexities are being compared.

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ACKNOWLEDGMENTS

Our thanks are due to Mr. W.J.A. Humphries for the design and construction of automatic thermocouple selector apparatus, and for the untiring and careful work carried out by Mr. C.A. Prigmore and Mr. G.W. Hicks over an arduous trial period of several weeks.

SUMMARY

Clothed men at rest were exposed to two conditioning "indoor" environments ("British", cool moist; "American", warm dry) for 45 minutes, and then to a cold environment (36°F) at moderate and high relative humidity (50% and 85%). The following measurements were taken: Temperature - skin, rectum and clothing gradients; nude body weight change and metabolism; subjective data. An attempt was made to measure clothing humidity gradients. The results showed that warm conditioning kept the clothing and skin at a higher temperature for a matter of 1½ hours or more during cold exposure. The physiological value of such conditioning may be less marked under field conditions. No physiological objective or subjective differences of practical importance were found between the effects of still air at 36°F at moderate or high humidity, except for the finding of a slightly warmer skin of the chest at the high humidity. These results agree fairly well with those of other workers for nude men.

From the date obtained there is no clear evidence that "sorption" heat of wool is an important factor in keeping the body warm at resting conditions. Under field conditions, "sorption" heat might be of still less value. There is no basis for the supposition that moist air is either a better thermal conductor or a more efficient heat convector than dry air. The physiological difference between "dry cold" and "damp cold" is not due to properties of humid air, but to the associated weather or climatic differences (solar radiation, cloud cover, wind, barometric pressure, etc.) and, to some extent, to the mode of living indoors. Data from physical models and from physiological experiments in climatic chambers cannot be directly transposed into the realities of weather and climate out of doors.

Fig. 1 CLOSE-UP OF HUMIDITY ELEMENT
The outer threads are for protecting the film

Fig. 2 HUMIDITY ELEMENT EXPOSED

Fig. 3 THERMOCOUPLE HARNESS
Arrows show position of guaze button, thermocouples and wire leading to rectal element.

FIG. 4.

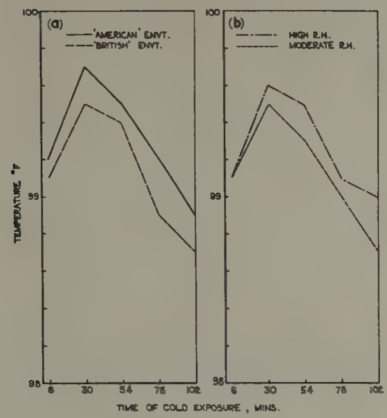

FIG 4. RECTAL TEMPERATURES.

(a) EFFECT OF CONDITIONING ENVIRONMENTS ON COLD EXPOSURE.

(b) EFFECT OF COLD ENVIRONMENTS.

(32 EXPERIMENTS PER ENVIRONMENT).

FIG.5

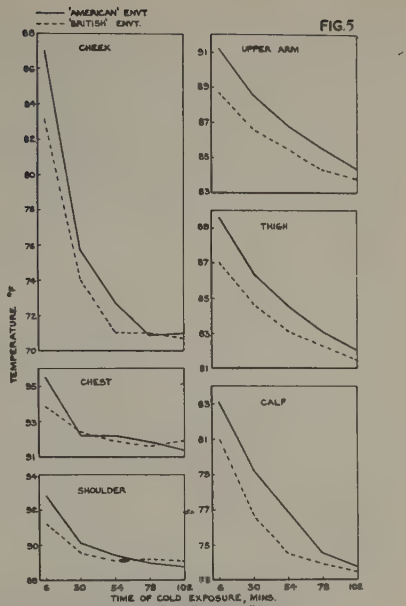

FIG.5 SKIN TEMPERATURES.

EFFECT OF CONDITIONING ENVIRONMENT ON COLD EXPOSURE.

(32 EXPERIMENTS PER ENVIRONMENT)

FIG. 6

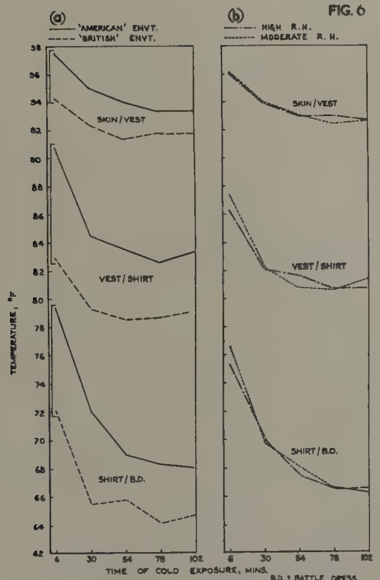

FIG. 6. TEMPERATURES BETWEEN CLOTHING LAYERS.

(a) EFFECT OF CONDITIONING ENVIRONMENTS ON COLD EXPOSURE.

(b) EFFECT OF COLD ENVIRONMENTS.

(24 EXPERIMENTS PER ENVIRONMENT)

FIG.7.

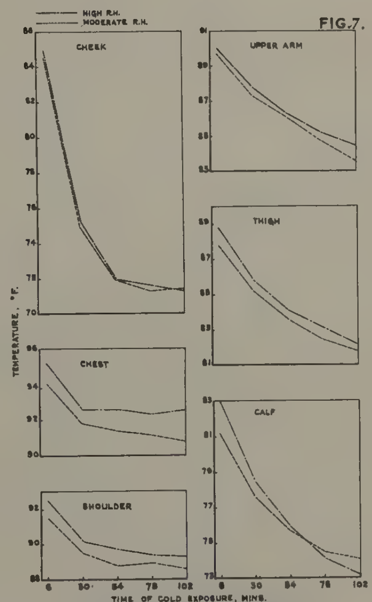

FIG. 7. SKIN TEMPERATURES.

EFFECT OF COLD ENVIRONMENTS

(32 EXPERIMENTS PER ENVIRONMENT)

Section B : Social bioclimatology

1. Social bioclimatology (general)
2. Psychological bioclimatology (including aesthetoto-bioclimatology)
3. Archeological bioclimatology

HUMAN BIOCLIMATOLOGY

Section B 2: Psychological Bioclimatology

PARTICIPATION OF SOME METEOROLOGICAL FACTORS ON THE DETERMINATION OF EMOTIONAL REACTIVITY

by

J. Wellnerová and D. Svorad (Czechoslovakia)*

I. INTRODUCTION

It is widely accepted that the weather is in close connection to the behaviour of man, particularly to human emotionality (8, 2). Emotionality can, to a certain degree, be considered to be correlated with vegetative regulations at their highest levels in the hypothalamus (5). There were found two constitutional types of reactivity in rats (13, 15, 16, 17, 18). One of them is characterized by a vegetative, emotional and generally functional lability (rats functionally unstable or emotionally reactive, 19), the other functionally stable, emotionally unreactive. This finding has been affirmed substantially later (1). With regard to the mentioned connection between vegetative functions and emotionality on the one hand and human emotionality and meteorological influences on the other hand, we tried to find out the changes of emotionality occurring under the influence of temperature and air humidity on emotionally reactive (ER) and emotionally nonreactive (ENR) rats.

II. METHOD

Experiments were carried out on white male rats of the Wistar strain aged approximately 4 months. There were 9 - 11 animals in one experimental group.

Emotionality was tested in several ways: by Hall's tests (9, 10), by the modified open-field test (4) and by the timidity test (3). All these tests are based on the presumption that the exposure of the animal to a strange, fear-provoking situation can evoke the emotion of fear expressed by defecation, running (ambulation) or disability of hungry animals to take food.

HALL'S DEFECATION TEST OF EMOTIONALITY: The animal is exposed to a sound and light stimulus (2 bells, 2 buzzers, a 40 W bulb) for 2 minutes on four successive days in an arena 50 cm in diameter and height. Emotional defecation, expressed by the number of faecal boluses, was taken as the criterion.

HALL'S AMBULATION TEST OF EMOTIONALITY: The conditions are the same as in the previous test. The number of metres run by the animal on the floor of the arena, which is devided into equal squares, during an exposure lasting for 2 minutes, is counted.

THE MODIFIED OPEN-FIELD TEST: Food is placed in the middle of the arena. The time which the hungry animal spends on food during a 10 minutes exposure is taken down (maximum score 600 sec.).

TIMIDITY TEST: The cage with the hungry animal is placed at the end of a 12.5 cm wide and 125 cm long wooden runner, resting on two supports 90 cm high. At the beginning of the test the cage is placed in such a position which enables the animal to crawl into the runner. The time taken by the animal to reach the food at the far end of the runner is taken down. This time is the timidity measure of the animal. If the animal does not leave the cage for 35 minutes, the test is finished and the animal has an arbitrary score of 2000 sec. If the animal puts its two front paws outside the cage but does not leave it, the score is 1800 sec.

The animals were kept in surroundings at a temperature of 18° C and 53% relative air humidity. Emotionality tests were carried out under conditions of variable temperature (21,27 and 33° C) and air humidity (50, 70 and 90%). Exposure of animals to a certain temperature and air humidity was always limited to the duration of the test.

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III. RESULTS

1. EMOTIONAL DEFECATION: Fig. 1 shows that difference in the emotional score between ER and ENR rats is maintained by using different air temperature and air humidity. A temperature of 33°C at air humidities of 50% and also of 70% and 90% leads to an increased emotional score in ENR rats which at the higher humidities is at the level of the emotional score in ER rats. At temperatures of 21° C and 27° C, in conditions of variable air humidity there is a positive correlation $r = 0.69 \pm 0.08$ between the emotional characteristic of the animals (i.e. ER and ENR) and their defecation reactivity. It is further possible to deduct from the results of these experiments that an increase of temperature and air humidity is not followed by any significant changes in the defecational score in ER rats. Compared with the defecation score at 21° C this score is increased significantly in ENR rats at a temperature of 33° C and corresponding air humidities of 50% ($P < 0.001$), 70% ($P < 0.05$) and 90% ($P < 0.01$).

2. EMOTIONAL AMBULATION: Hall (10) found that there is an indirect connection between emotional defecation and emotional change of locomotor activity in the open-field test. The results of our experiments with emotional ambulation (Fig. 2) in ER and ENR rats show that a statistically significant difference in these two types of rats is maintained in ambulatory activity in several combinations of temperature and air humidity, but this was not significant at 50% air humidity and 33° C temperature, and at 90% air humidity and 27° C and 33° C. The figure shows further that increased temperature and air humidity raises also the emotional ambulation of ER and ENR rats. This increase is statistically insignificant, except for a significant increase at the level of $P < 0.05$ between 70% and 90% of air humidity at 33° C of air temperature in ER rats.

3. THE REACTIVITY IN THE MODIFIED OPEN-FIELD TEST: Contrary to the previous test situations, the influence of increased air temperature and air humidity on the emotional behaviour makes itself felt significantly in the open-field test. Emotional reactivity (or fear-reaction) of ENR rats increases significantly the more, the higher the temperature and humidity of air. In Fig. 3 the difference between the score of 50% and 90% of air humidity at 21° C is significant at the level of $P < 0.003$, at 33° C at the level of $P < 0.001$. Between the values of 21° C and 33° C of air temperature and at 50% air humidity there is no significant difference, but the difference is significant at the level of $P < 0.05$ at 90% air humidity.

4. THE RESULTS OF THE TIMIDITY TEST IN ENR RATS (Fig. 4): It is shown that air temperature and air humidity are decisive factors for emotional reactivity. The higher the temperature and humidity of air, the higher also the score of this test. The difference of score between 50% and 90% is significant at a temperature of 21° C at the level of $P < 0.001$ and at 33° C at the level of $P < 0.02$; on the other hand there is no significant difference between the score at 21° C and 33° C either at 50% or at 90% of air humidity.

IV. DISCUSSION

Emotional reactivity is a variable function determined by a number of factors (6). In an experimental situation where only air humidity and air temperature vary, reactivity changes significantly. Therefore it can be concluded that temperature and air humidity are also determining factors for emotional behaviour. The exposure of the animal to varying temperature and air humidity was in our experiments carried out over a relatively short time. It is, therefore, possible to presume that the accomplished results are only to a certain extent expressing the absolute values of temperature and air humidity. They could be the results of a gradient of change of these two meteorological factors (i.e. the transition from temperature and air humidity, in which the animals were kept, to the temperature and air humidity of the experimental situation). This sudden change of temperature and air humidity leads to an increased emotional unsteadiness of the animal which is not expressed equally in all tests of emotionality used. It is likely that each of the tests expresses a certain, reciprocally different component of emotionality. This opinion is confirmed by substantially similar results in the defecation and ambulation test which have a common test situation and differ only in the registration of a different (defecative or ambulatory) activity of the animal.

The presented results show further that the reactivity to air temperature and humidity is also an individually variable function. It is known (11, 17) that there are significant differences in the constitutional disposition of man to perceive meteorological changes. But these differences can disappear at a high temperature and air humidity as shown by the results of these experiments.

We presume that the facts about a different reactivity to meteorological influence on rats, which differ by their constitution, can bring new aspects to some psychopathological syndromes of human behaviour which can be studied on the experimental model of the so called animal hypnosis (14, 17). This reaction, called by Kretschmer (12) the phylogenetic precedent of human hysteria and other emotional disorders, is noticed in those very rats described as ER. By proving the reactivity of these rats to some meteorological influences, the way to a better understanding of the connection between human emotionality (or its disturbances) and some meteorological factors can be facilitated.

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SUMMARY

Rats were exposed to conditions of various temperature (21, 27 and 33° C) and air humidity (50%, 70% and 90%) and their emotional reactivity was estimated.

Increased temperature and air humidity increases more or less expressively the emotional reactivity. It was further stated that interindividual differences of emotional behaviour are maintained in conditions of lower levels of variously warm and humid air.

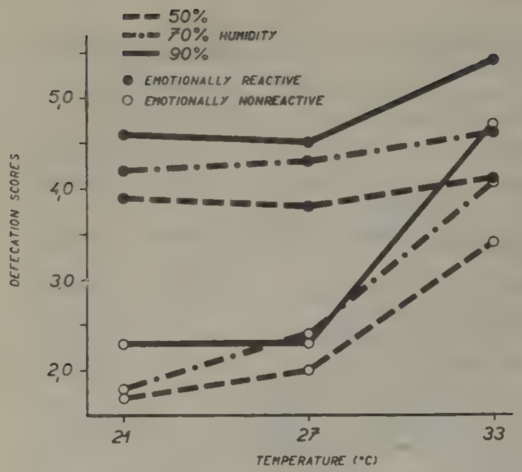

Fig. 1 Influence of various temperature and air humidity on emotional defecation. (Defecation score is expressed by an average amount of boluses during one test exposure).

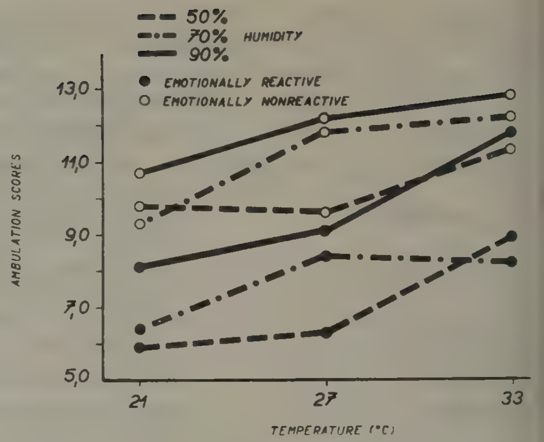

Fig. 2 Ambulation under conditions of various temperature and air humidity. (Ambulation score: average amount of meters during one test exposure).

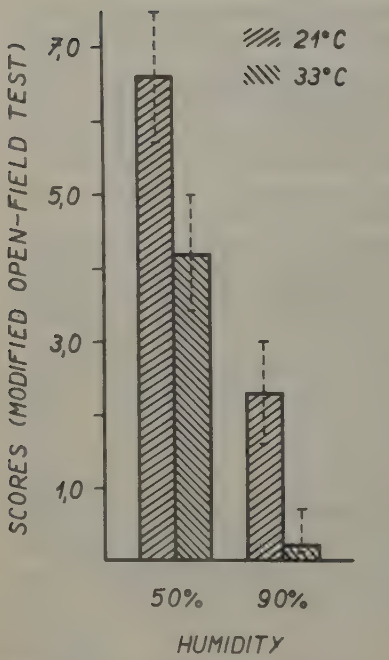

Fig. 3 Reactivity in the modified open-field test under conditions of various temperature and air humidity. (Score: average amount of minutes and its standard error).

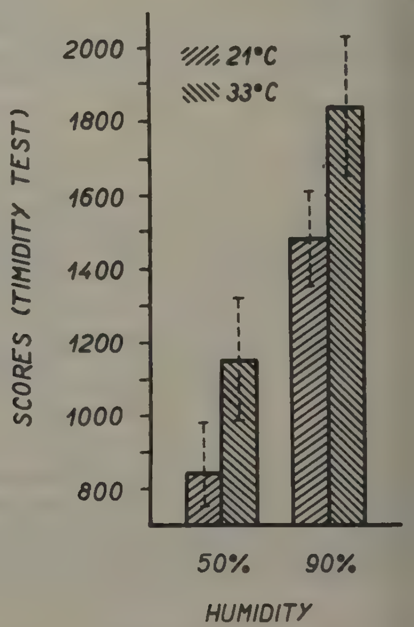

Fig. 4 Reactivity in the timidity test. (Score: average amount of minutes)

HUMAN BIOCLIMATOLOGY

Section B 2: Psychological Bioclimatology

TEMPERATURE AND AIR HUMIDITY AS FACTORS INFLUENCING SLEEP AND WAKEFULNESS

by

D. Svorad and J. Wellnerová (Czechoslovakia)*

I. INTRODUCTION

The rhythm of sleep and wakefulness is one of the basic biological factors. Although it is doubtful whether it is of a predominantly exogenic or endogenic origin (2, 13, 15), it is known that changes of environment, introduced gradually, do not disturb it greatly. On the other hand, the aperiodic influence of meteorological factors of a certain gradient can lead to its deep changes, expressed by insomnia (1, 4, 7).

It seemed useful to verify these empiric data by experiment because in that way it is possible to expose the organism to isolated meteorological factors and define quantitatively their biological significance (11). There are only limited possibilities of doing such an experiment on man, and it is more convenient to use animals.

The aim of this work was to find out the effect of temperature and air humidity on the rhythm of sleep and wakefulness, in certain experimental situations.

II. METHOD

Experiments were carried out on male rats of the Wistar strain at the approximate age of four months. There were 8 - 10 animals in one experimental group.

The rhythm of sleep and wakefulness was registered by an electronic actograph, i.e. a photoelectric circuit with amplifier brought into action by the spontaneous activity of the animal. The spontaneous activity was registered by an electric counter. The criteria of sleep and wakefulness depended on the frequency of spontaneous activity on the counter.

Insomnia was evoked by a system of relay circuits switching on a battery of acoustic, optical and vibrating stimuli at certain time intervals. By combining single stimuli with an electric shock into the paws of the animal, it is possible to elaborate a conditioned emotion of fear (6, 15) which, being continuously activated, does not allow the animal to fall asleep.

Air humidity was measured by a psychrometer. Further methodic data are given below.

III. RESULTS

1. CHANGES IN THE DURATION OF SLEEP AND WAKEFULNESS AT DIFFERENT TEMPERATURES AND AIR HUMIDITIES.

For 24 hours 4 groups of rats were exposed to different temperature and air humidity conditions based on the combination of two different kinds of temperature and air humidity. At the same time, the spontaneous activity of the animals was measured as the index of sleep and wakefulness. Fig. 1 shows that both at 21°C and at 27°C an increase of wakefulness, or decrease of sleep was present at a higher air humidity, compared with the values at lower air humidity. At the temperature of 21° C this difference was significant at the level of $P<0.001$ and at 27° C at the level of $P<0.01$.

The influence of temperature and air humidity on insomnia was followed in a further series of experiments. In all these experiments insomnia was evoked in the above mentioned manner for 24 hours at a temperature of 18° C and 53% air humidity. In the first part of the experiments animals were exposed to conditions of different temperature and air humidity for one hour before

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evoking insomnia and after that the influence of the exposure on insomnia was followed. In the second part of these experiments an exposure lasting one hour was carried out during insomnia. In both cases only temperature and air humidity of the exposure varied. The influence of the exposure on insomnia was measured by the sleep debt. Sleep debt (10) expresses the disturbance of the usual ratio of duration of wakefulness and sleep in the cycle of sleep and wakefulness of the given individual. It can occur if the usual duration of the phase of wakefulness is lengthened. In man it evokes a feeling of muscle lassitude and of being "below par". Individuals, accumulating such a deficiency of rest, may feel that they could return to "normal" by prolonging tha duration of sleep in one single night (for example considerably prolonged sleep on Sunday mornings). Sleep debt in our experiments is not expressed by the length of sleep but by the lower intensity and frequency of spontaneous activity. In all our experiments we measured the sleep debt by one hour recording of spontaneous activity of the animal at a temperature of 18° C and 53% of air humidity. Since there is a rather great diurnal variation of spontaneous activity in rats, records were always taken between 7 and 8 p.m. The intact animal (i.e. one with an undisturbed rhythm of sleep and wakefulness) has an actographic value of 834 $\pm$ 196 at that time of day. After 24 hours of insomnia, ending always at 7 p.m., spontaneous activity was lower (i.e. sleep debt higher) than the one measured on an intact animal. Its values, as shown in Fig. 2 and 3, were always influenced by the temperature and air humidity of the exposure. These findings were also significant.

2. INFLUENCING SLEEP DEBT BY EXPOSURE TO VARYING TEMPERATURES AND HUMIDITIES BEFORE INSOMNIA.

In the first place, the animals were exposed to conditions of various temperature and air humidity (fig. 2) on a single occasion. The exposure lasted one hour. After that the animals were kept awake for 24 hours at a temperature of 18° C and 53% air humidity. After the end of insomnia their "need for sleep" was measured by sleep debt (in values of spontaneous activity at a temperature of 18° C and 53% air humidity). Fig. 2 gives the results of these experiments. It shows that sleep debt increased at the same ratio as the temperature and air humidity of the exposure. The increase of air humidity from 70 to 90% led to a statistically significant lowering of spontaneous activity (i.e. to an increase of sleep debt) at all temperatures used in the experiment. Likewise there was a significant difference between the height of sleep debt at 50 and 70% of air humidity at the temperature of 27 and also of 33° C. On the other hand, the increase of air temperature, e.g. from 27 to 33° C, had effect only at 90% air humidity ($P < 0{,}01$).

3. INFLUENCING OF SLEEP DEBT BY THE EXPOSURE APPLIED DURING INSOMNIA.

Insomnia, lasting for 24 hours, was evoked in the animals. After 12 hours of insomnia the animals were exposed to various degrees of temperature and air humidity for a single time. This exposure lasted for one hour (Fig. 3). In a further experimental variant, four exposures instead of one were carried out during insomnia (at approximately 5 hours intervals, each exposure lasting again 1 hour). The results of both these experiments (fig. 3) did not differ greatly and were practically the same as the results of the preceeding exposure (Fig. 2). It follows that the higher the air humidity at a given temperature, the lower the spontaneous activity of the animal, i.e. the higher sleep debt.

IV. D I S C U S S I O N

Results of the submitted experiments show the significant influence of both air temperature and air humidity on the rhythm of sleep and wakefulness.

Both studied stimuli differed basically from others influencing the organisms. In the first place, there is their continuous influence on the organism. Whereas other outside influences stimulate various receptors at periodic or aperiodic intervals, air humidity and air temperature act continuously on the organism. Thus they are continuous signals. The organism, aided by its regulative and compensative systems, working on the principle of an automatic control with feedback (3) can keep the homeostasis (9, 18). It can adapt itself to changes of its environment only to a certain extent. If the possibilities of its adaptability are overstepped, in our case the thermoregulative ones, a general reaction, i.e. a general escape reaction, sets in. To bring about an escape reaction, brain activity, not compatible with the state of sleep, has to be assumed. Therefore it is possible to presume that a drastic and continuous stimulus which does not allow the organism to protect itself by means of intelligent activity (clothes and ways of living, 8), will result in the disturbance of the normal rhythm of sleep and wakefulness. This is confirmed by the results of the submitted experiment.

The peculiarity of warm and humid air as a stimulus is given by the fact that these stimuli have an extraordinarily wide receptor field, presented by the whole surface of the body, and that the organism, therefore, has no possibilities to exclude the reception of these stimuli as is the case with stimuli attacking other exteroceptors and distance receptors. The result is a lasting

afflux of impulses which disturb the regulative mechanisms of sleep and wakefulness (12, 16).

An exposure lasting one hour, irrespective to the time of its application, is a stressor (14) which cannot be compensated by the organism. This explains the practically identical effect of the exposure preceeding insomnia and the exposure applied during insomnia on the one hand, and a single and repeated exposure on the other hand.

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SUMMARY

In experiments on rats we studied the influence of temperature (21, 27 and 33° C) and air humidity (50, 70 and 90 %) on the duration of sleep and insomnia.

The sleep of an animal, exposed to variously warm and humid air for 24 hours, is shortened the more, the higher the humidity and temperature of air. After insomnia lasting 24 hours and preceeded by an exposure to variously warm and humid air for one hour, sleep debt is increased at the rate at which air humidity and temperature of the exposure is raised. Similar changes of the animal's sleep depth occur also in such cases where the exposure of the animal is carried out during insomnia.

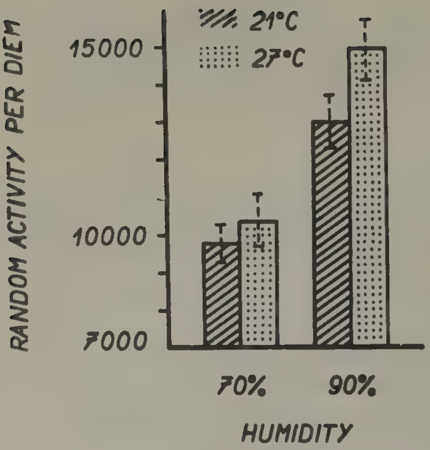

Fig. 1 Spontaneous activity (wakefulness) of the rat in conditions of various temperature and air humidity. Spontaneous activity is expressed by values obtained from the electric counter. (Average value for one animal and its standard error).

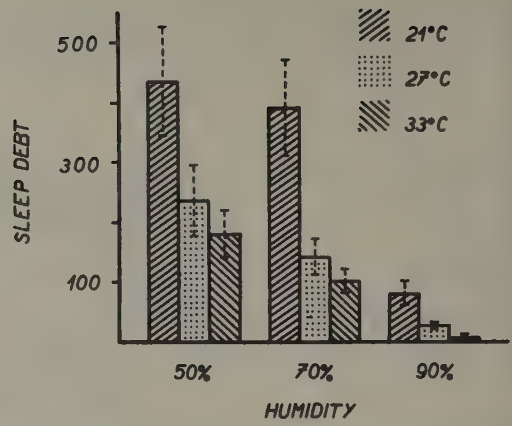

Fig. 2 Sleep debt after a single exposure of the animal to conditions of variable temperature and air humidity. (A one hour exposure carried out before the 24 hours insomnia). Sleep debt expressed in values obtained from the counter of spontaneous activity (mean and its standard error).

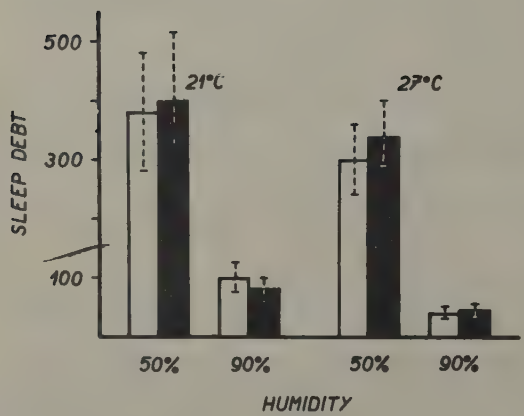

Fig. 3 Sleep debt after a single and repeated exposure of the animal carried out during the 24 hours insomnia.
White columns: a one hour exposure during insomnia.
Black columns: four one hour exposures during insomnia.

Section C : Pathological bioclimatology

1. General pathological bioclimatology
2. Meteorological pathology
3. Climatological pathology
4. Air pollution pathology
   a. Pollution with organic particles (pollen, fungi, etc.)
   b. Pollution with inorganic particles (dust, etc.)
   c. Chemical pollution
5. Geographical climatopathology
6. Climatotherapy
   a. General Climatotherapy and Therapeutic Climates
   b. Thalassotherapy (climatological-)
   c. Heliotherapy
   d. Thermotherapy
   e. Aerosol therapy (and Iono therapy)
   f. Socio-climatotherapy
   g. Climatic health resorts
   h. Other therapeutic methods

HUMAN BIOCLIMATOLOGY
Section C 6 e: Ionisation Therapy

A STUDY OF BIOCHEMICAL AND HAEMATOLOGICAL CHANGES UNDER THE APPLICATION OF IONIZED AIR

by

Ludvík Erban (Czechoslovakia) *

I. INTRODUCTION

During the last decade a number of papers have been published in the medical literature dealing with the influence of ionized air on the organism. By ionized air we mean an atmosphere which contains electrically charged particles, consisting of single atoms, their groups (ionized molecules) or of bigger aggregations of different origin.

The first to call attention to the effects of ionized air, was the prominent Russian hygienist J.P. Skvortsov who studied, as early as about 1900, the influence of atmospherical electricity on human organisms. Later on, the subject was studied by Dessauer, Rajevski, Sokolov, Strassburger, Happel, Frey, Michalovicz, Vasiljev, Tchijevsky, Busigina, Minch, Hicks, Hansell and others. Most of these papers concerned the examination of subjective sensations of test persons, the changes of blood pressure, respiration frequency, basal metabolism, chronaximetry, and, in some cases, also changes in the blood picture and sedimentation rate. In animals, changes of the total body weight, the weight of organs and growth of hair were investigated histologically, as well as changes in the thyroid and adrenal glands. The results obtained by different authors in applying positively and negatively ionized air, are very inconsistent. The experiments were carried out under different conditions. Different doses of ions were applied with different lengths of exposures and the ionized air contained a mixture of a smaller or greater predominance of positive or negative ions. Nevertheless most of the authors agree in the finding that negatively ionized air causes comfort, tranquilization, euphoria, and reduces blood pressure, while positively ionized air has opposite effects. These findings have promoted the use of ionized air for therapeutic purposes especially in the treatment of hypertension.

Although clinical, histological and physiological methods were used in the investigation of the influence of air ions, modern biochemical methods have not yet found sufficient application in this field. For this reason, as well as for their relatively high degree of objectivity, we have directed our attention particularly to these methods. Unlike most of the quoted authors, our studies were not limited to the influence of short time exposures but especially to the chronic effects of regular doses repeated over a prolonged period of time.

II. EXPERIMENTAL

The group of test persons consisted of men aged between 25 to 45 years. For technical reasons it was not possible to follow any group of control persons. The test persons inhaled artificially ionized air which was obtained by irradiating a current of atmospherical air by a radioactive substance placed in an apparatus. The device consists of a cylinder (about 8 cm. diameter) in which a thin plate of an alpha emitting radioactive substance is inserted. A constant current of clean air was introduced by means of a ventilator placed outside the experimental room. The ionization of air fluctuated round 4 million positive and negative ions in 1 ml. In the first series of experiments most of the negative, and in the second series most of the positive ions were eliminated by an electrostatic field, so that the test persons were inhaling predominantly positive ions in the first series of experiments and negative ions in the second series, the number of undesirable ions not exceeding 3 per cent of the total number.

The exposures lasted 1 hour and were applied to each person continuously 3 times a week, regularly for a period of 8 weeks in each of the both series. The second series was carried out with practically the same group of persons as the first one but about 3 months later.

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The following values were observed:

A. before and after each exposure: blood pressure
temperature
pulse

B. once a week:
1. content of Na^+, K^+ and Ca^{2+} in blood by a flame photometer.
2. total content of cholesterol colorimetrically on the principle of the Liebemann-Burchardt reaction - the green colouring with acetanhydride and sulphuric acid - and particularly it's free as well as it's ester bound part with column chromatography.
3. total content of protein refractometrically.
4. content of separate protein fractions with paper electrophoresis of our own modification, using slips of paper freely stretched in the air, closed in a humid chamber.
5. content of the 17-ketosteroids in urine with the common Robbie Gibson method.

In addition, blood pressure and sedimentation rate controls were carried out weekly, for orientation.

III. RESULTS

The results obtained were statistically evaluated for each value under investigation so that the average values of parallel data, obtained in all test persons, were fixed and the amount of statistical dispersion was determined:

$$\sigma = \sqrt{\frac{\Sigma \Delta^2}{n - 1}}$$

Further, with regard to blood pressure, also changes between the value before the exposure and after it were computed and evaluated in the same way. The average values and the marked limits of the dispersion were put into graphs, dependent on time.

IV. DISCUSSION

The first series of experiments with positive ions has shown that the blood pressure continuously rises throughout the whole experiment and this finding indicates a cumulation of effects. The rise is more significant in the systolic pressure that increased during the whole 8 weeks' experiment by 18 mm Hg (Graph 1).

Graph 2 shows the change of blood pressure during the exposure. This change is a kind of measure of sensibility of the blood pressure response to the applied dose of aeroions. It appears that the response of the organism becomes more expressive with repeated applications of positive aeroions. During the first ten days of the experiment the systolic pressure showed a slight decline, as the test persons mostly fell asleep after the beginning of the experiment. Although they used to fall asleep during the application of air ions after the tenth day too, the increase of their systolic as well as diastolic pressure above the values before the experiments appeared quite distinctly.

Graph 3 shows the changes of the total cholesterol and its fractions. The decrease of the total content of cholesterol is due substantially to the decline of the free cholesterol.

The total content of proteins in the serum is not influenced at all. On the contrary, the protein fractions show more striking shifts (Graph 4). While a decrease of albumins can be observed, signs of an increase appear in alpha, beta and gamma globulin.

In the course of inhaling positively ionized air, the content of the 17-ketosteroids in urine increases (Graph 5).

The blood picture did not show any changes and neither did the sedimentation rate.

The second series of experiments with negative ions that - according to literary statements - influence the organism favourably, has not shown any perceptible influence on the blood pressure (Graph 1), perhaps only an insignificant decline of the diastolic pressure.

As to the changes of the blood pressure during the exposure to negative ions (Graph 6), the systolic pressure shows a slight decrease which is however constant during the whole experiment. This is evidently the simple influence of tranquility or sleep. The diastolic pressure shows signs of falling, but the changes are within the limits of the dispersion so that it is possible that they are a matter of occasional fluctuation of results.

When negatively ionized air was applied, no changes either in the total content of cholesterol or in the content of its fractions were observed (Graph 7).

The total content of proteins in the serum did not change, not even when negative ions were

inhaled. Yet the protein fractions showed changes (Graph 8) which are opposite to those occurring under positive ionization. The albumins increased and globulins decreased.

The values of the 17-ketosteroids show an increase similar to those in the positive ionization but this increase is more moderate here (Graph 9).

The blood picture does not show any significant changes. It is only possible to observe an insignificant sign of a raise in the number of erythrocytes and a fall of the haemoglobinv, but both these effects lie fully within the limits of the statistical dispersion. Also the mineral metabolism is not significantly affected, neither by positive nor negative air ions.

V. CONCLUSION

On the whole, the findings indicate an evident influence of the chronic administration of air ions. Especially positive ions show such an influence, where the whole picture of changes conspicuously reminds us of the complex of changes observed during the administration of ACTH.

Negative ions show much less definite effects. As the experiments were carried out on healthy individuals we had no occasion to ascertain if negative aeroions favourably influence a sick organism, as quoted in the literature. It is possible that the insignificance of the effects of negative ions in our experiments were due partly to the fact that the apparatus we had to our disposition did not emit ions of exclusively one sign. An admixture of a small number of positive ions could interfere with the effect of negative ions if it existed.

The existence of a chronic influence of aeroions under longterm administration, the signs of which have been ascertained in the above described experiments, will be subject of a further, more detailed, experimental study.

VI. SUMMARY

This paper deals with the study of the influence of artificially ionized air on human organisms. An attempt has been made to estimate objectively this influence by exact methods, especially by biochemical ones. A group of test persons inhaled positively ionized air during a period of two months at regular intervals (3 times a week during one hour) and they inhaled negatively ionized air during the second part of the experiment. The positive ionization caused an increase in the blood pressure. In blood proteins the albumins decreased and globulins increased. The total and the free cholesterol fell and the 17-ketosteroids increased. The negative ionization did not affect the value of the blood pressure and its effect was observed in the increase of albumins and the decrease of globulins. The other tests did not show any synonymous changes.

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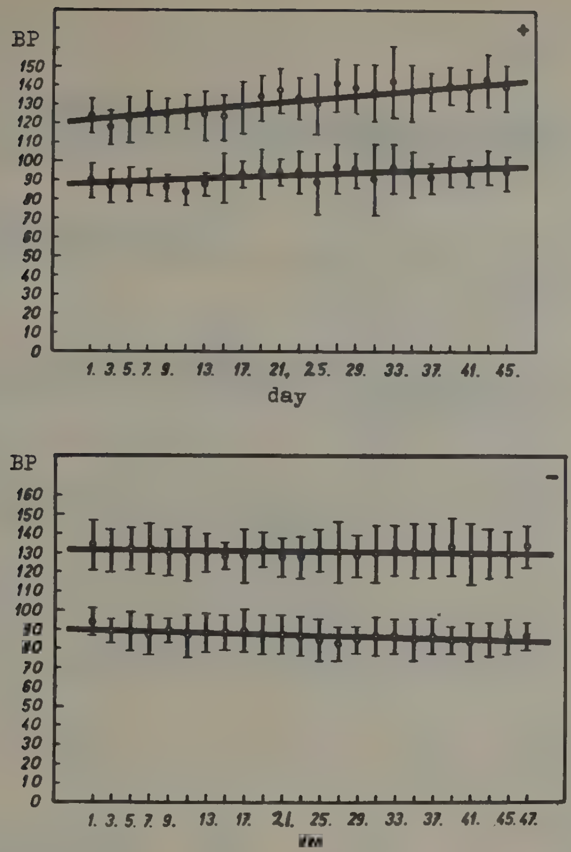
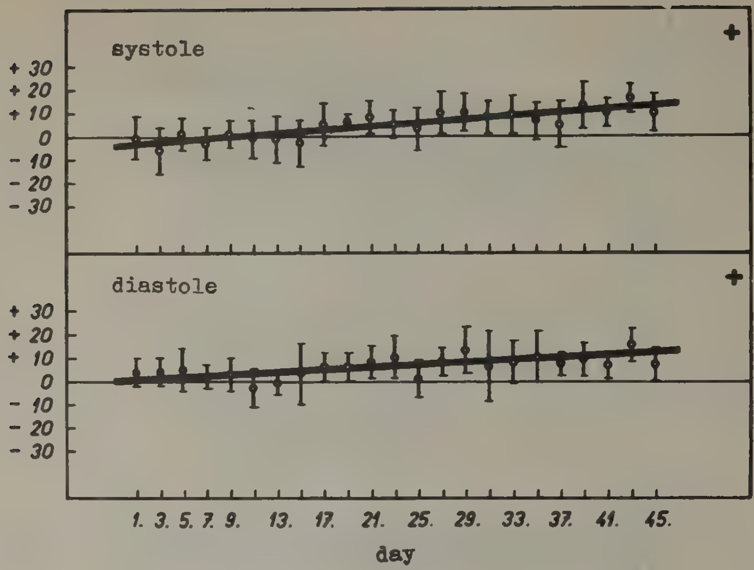


Graph 1.

above: changes of the blood pressure during the application of positively ionized air measured at the end of each inhalation.

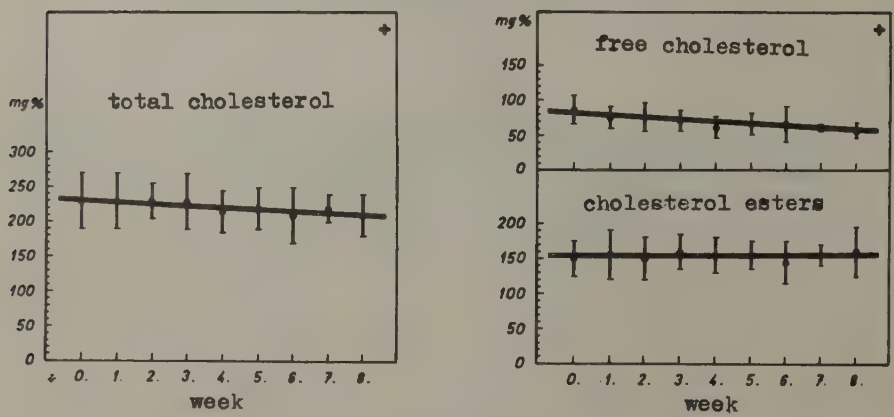
below: changes of the blood pressure during the application of negatively ionized air measured at the end of each inhalation.

(Averages with marked dispersion)



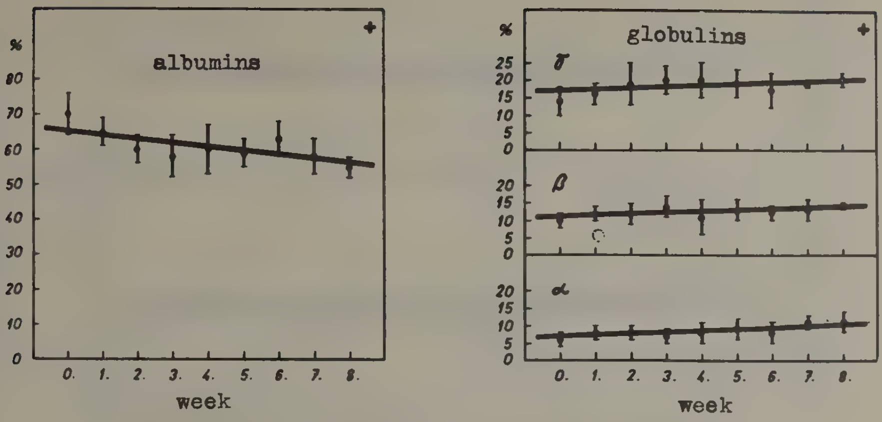
Graph 2.

Sensibility of the blood pressure to aeroions. Differences of the blood pressure before and after the inhalation of positively ionized air with marked dispersion.



Graph 3.

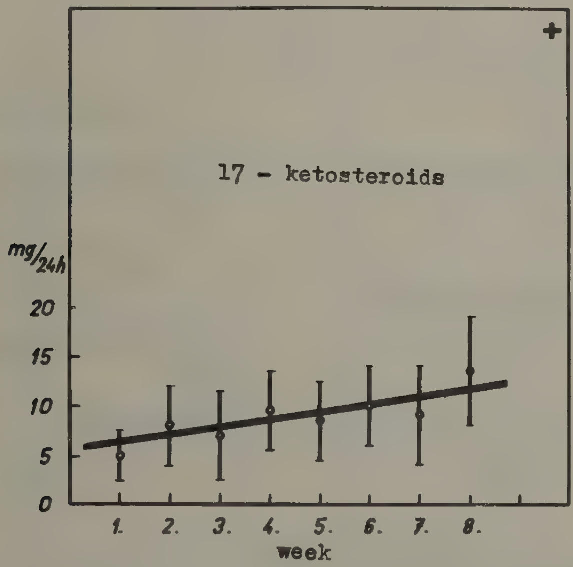
Changes of the total cholesterol and its fractions in dependence on the duration of the positively ionized air inhalation.
(Averages with marked dispersion)



Graph 4.

Electrophoretic analysis of blood proteins on the filtration paper. Changes in the protein spectrum in test persons inhaling positively ionized air during 2 months.

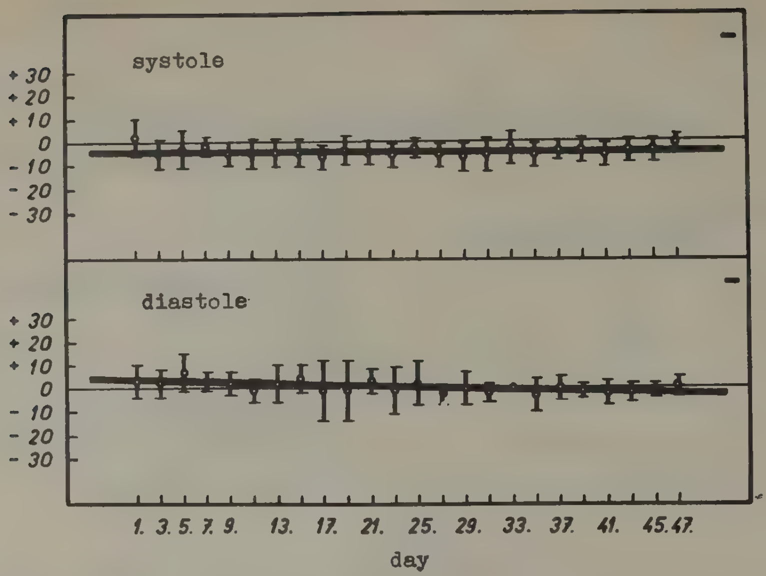
(Averages with marked dispersion)



Graph 5.

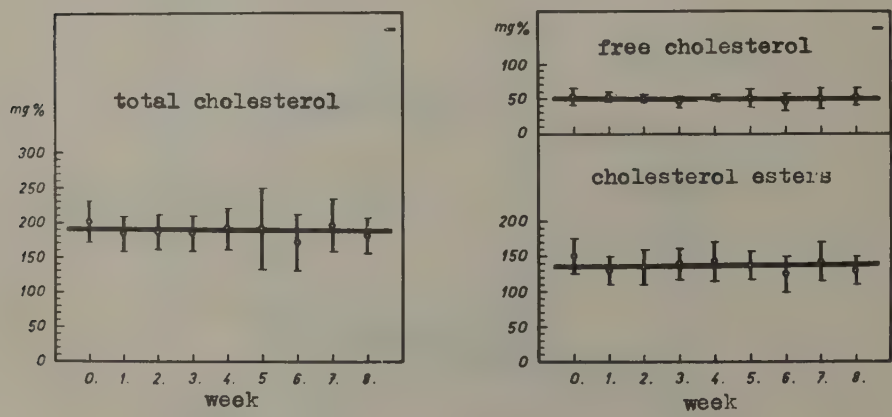
Increase of the 17-ketosteroids in urine in the course of the inhalation of positively ionized air.

(Averages with marked dispersion)



Graph 6.

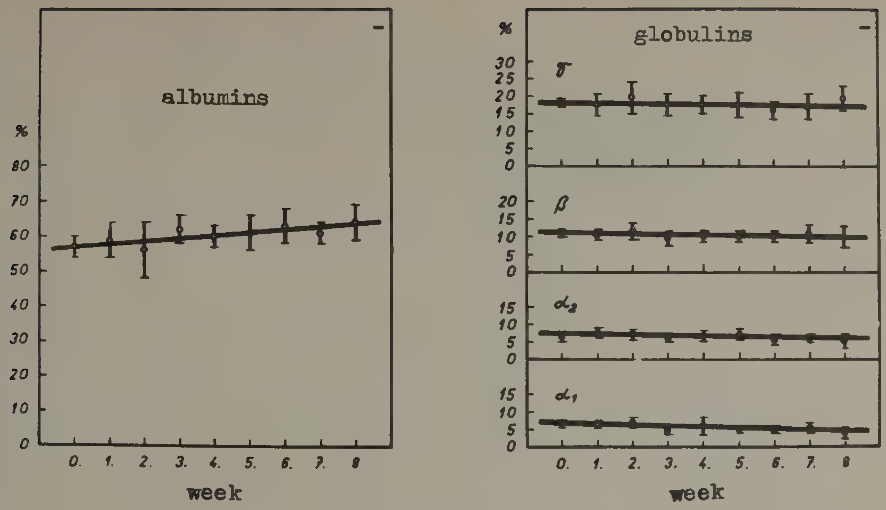
Sensibility of the blood pressure to negative aeroions. Differences between the blood pressures after the inhalation of artificially ionized air with marked dispersion.



Graph 7.

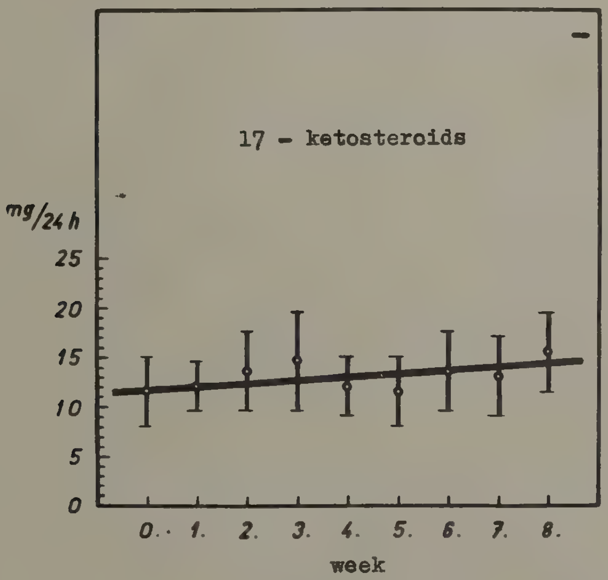
Cholesterol and its fractions in dependence on the duration of the negatively ionized air application.

(Averages with marked dispersion)



Graph 8.

Changes in the protein spectrum ascertained by means of electrophoretic analysis of the blood proteins on the filtration paper in test persons inhaling negatively ionized air during 2 months
(Averages with marked dispersion)



Graph 9.

Values of the 17-ketosteroids in the course of the inhalation of negatively ionized air.
(Averages with marked dispersion)

Section D : Urban bioclimatology

1. General urban bioclimatology
2. Architectural bioclimatology
3. Sanatorium bioclimatology

Section E : World literature

HUMAN BIOCLIMATOLOGY

Section E: World literature *

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PART V

COSMIC BIOCLIMATOLOGY

(1959)

Section A : General cosmic bioclimatology

P A L E O - B I O C L I M A T O L O G Y

Section A: General paleo-bioclimatology

THE IMPACT OF PALEOMAGNETISM ON PALEOCLIMATIC STUDIES

by

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Throughout the history of geology there have been many efforts made to interpret the climates of the geological periods. The methods employed have varied widely and have met with varying success. As we might suppose the climate of the Cenozoic (2) is much better known than the climate of earlier geologic time. This is largely due to the fact that many existing flora and fauna have survived from the earlier Cenozoic or have closely related Tertiary forms; therefore, it is possible in many cases to infer the climatic conditions of the Cenozoic by extrapolation from the climatic zones occupied by these forms today.

However as we go back in time to the earlier geologic periods confusion reigns. This confusion is a direct result of finding climatic indicators in areas where they are not logically expected; such as coral reefs in Arctic areas, and the great evaporite (3) development in the Devonian of arctic and subarctic Canada. Also dramatically out of place are the tillites (4) of Africa, India, Brazil and Australia. These facts have lead to a number of contradictory theories concerning past climates. The hypothesis which is seen in many introductory texts on historical geology is the "uniformly warm earth theory" propounded to explain the occurrence of sediments indicative of warm conditions in the polar regions; however, in at least one period, the Permian, this hypothesis does not appear to be valid because climatic indicators show that while glaciers were in existence close to the equator it was warm in the Arctic regions. The only theory that has satisfactorily explained the apparent climatic distribution of the past is the theory of continental displacement first advocated by Taylor (1910) and Wegener (1912) and championed in recent years in a modified form by Dutoit, 1937; Carey, 1955; and King, 1953. This theory has not yet been accepted by the majority of geologists; however, it still remains as the only theory which satisfies most of the evidence.

In recent years a potentially powerful tool has been developed by geophysicists which promises to be of great value in solving the problems of Continental Drift and could be of great assistance to the paleoclimatologist. This new tool is paleomagnetism, which is the study of the magnetic field in the geologic past reconstructed by using the magnetic moments retained in certain igneous and sedimentary rocks; such as lava flows, red sandstones and shales. It has been shown by the workers in this field that certain rocks retain the direction and dip of the magnetic field which was active while they were being deposited. This allows the worker to determine the position of the magnetic pole relative to the locality where the specimens were collected. It has also been shown that over a length of time, long compared to the period of the secular variation, the magnetic pole will coincide with the geographic pole, thus allowing the determination of the latitude of the collecting site. (The writer will not attempt to describe in detail the techniques and assumptions used in measuring and in interpreting paleomagnetic results since excellent reviews are available. Runcorn, 1957) . Thus it is possible to determine the approximate latitude for a continent for any geological period in which suitable rocks are available.

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(2) As several members of I.S.B.B. may not be acquainted with the geological terminology used in this article and other ones related to Paleo-bioclimatology, in the annex attached a summary is given of the most important stratigraphic names which have been introduced to indicate different geological periods in the past (Editorial note).

(3) EVAPORITES are sediments which originate from water in hot climates by evaporation of lake- or seawater.

(4) TILLITES are boulder clay deposits of Late Carboniferous or Lower Permian age which were formed during an Upper Carboniferous Glacial Period in the present Southern Hemisphere.

It follows then that if the latitude of a particular continent for a period is known, it should be possible to construct a hypothetical climatic picture for the continent, taking into account the present distribution and causes of climate.

It has been shown that paleomagnetic results are in general agreement with paleoclimatic indicators (Irving, 1956; Schove et al., 1958); that is to say, that when paleomagnetic results indicate a position close to the equator the associated sedimentary deposits usually show evidence of a warm or arid environment (e.g. evaporites, desert sandstones, bioherms (5), bauxites (6); also it has been shown that when high latitudes are indicated, glacial tillites are sometimes associated with them (e.g. South Africa and Australia during the Permo-Carboniferous). Thus there is gross agreement between paleomagnetic results and paleoclimatology.

The next step would seem to be the constrcution of the probable climatic zones of continents for certain periods given the rough paleogeography of the continent and its position relative to the poles and equator. While it should be possible to construct probable climatic zones for a geological period given the aforementioned conditions, it must be kept in mind that any attempt at absolute accuracy in drawing the boundaries of the climatic zones will lead to difficulty; one reason being that modern climatic zones are drawn rather arbitrarily when in fact the different zones grade imperceptibly into one another. Another reason is that a rigid interpretation will lead to erroneous results if we take into consideration the fect that climatic zones are known to expand and contract. Climatic changes of this type are known to have taken place since the retreat of the last glaciers in Europe and North America. Profound changes of climatic zonation will occur during any major glaciation and are well documented for the Pleistocene.

Certain generalities regarding climate should be constant throughout geological time if the following axioms are true:

1. that the earth has rotated throughout time in the same direction without a large change in the velocity of rotation;
2. that the inclination of the earth's axis has remained at or close to its present value of 23° 26' 44.8" (Skilling and Richardson, 1947).

There is no reason to believe that these factors have significantly altered since the Cambrian because most of the other planets, whose direction of rotation and angles of inclination to the ecliptic are known, rotate on their axis counter clockwise, the same as the earth, and have comparable ecliptic angles (e.g. Mars is inclined to the ecliptic at an angle of 23°98') (7)

If these factors have remained more or less constant then the earth's relationship to the sun probably has remained the same through geologic time. This is important since the sun is the primary cause of the earth's atmospheric energy and climate. Since the earth possesses an atmosphere and is an oblate spheroid, it follows that more heat energy will always be available at the equator per unit area than at the poles. We have also seen that the earth's axis is inclined at an angle of $23\frac{1}{2}°$ which is directly responsible for the seasons. This causes total darkness above $66\frac{1}{2}°$ in December in the northern hemisphere and in June in the southern hemisphere. These facts cause the progressive lowering of the mean annual temperature from the equator to the poles. Furthermore, the sun through the heating of the atmosphere causes it to be set in motion If the earth were not rotating a single large cell would be developed rising at the equator and settling at the poles. This picture does not develop because the rotation of the earth exerts a force (the Coriolis force) on the moving air masses which breaks the large cell down into the components which are observed today: the prevailing easterlies or trade winds, the mid.latitude westerlies and the polar easterlies. These factors coupled with the physical geography of the earth cause climatic patterns.

Therefore, certain broad generalities regarding the earth's climate should hold true through geologic time.

A. THE PLANETARY WIND SYSTEM SHOULD REMAIN MUCH AS IT IS TODAY giving rise to an equatorial low pressure zone (0°), trade wind zone (0 - 30°), subtropical high (30 - 35°), zone of westerly winds (35 - 60°), subpolar low pressure area (65°), polar easterlies (65 - 90°) and a polar high pressure area (80 - 90°).

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(5) BIOHERMS or ORGANIC REEFS: name introduced in 1928 by Cunnings and Shrock to indicate reef-like, moundlike or lens shaped carbonate masses consisting chiefly of debris from organisms (coral, algae, crinoids etc.) and surrounded by impervious rocks.

(6) Under certain conditions in tropical climates all the silica of felspar minerals may be removed by weathering. The residue left is called BAUXITE, a mixture of two aluminous minerals ($Al_2O_3.H_2O$ and $Al_2O_3.3H_2O$), often a valuable aluminium ore.

(7) URANUS is an exception having a very steep ecliptic angle of 98° and is rotating clockwise.

B. PRECIPITATION WOULD ALSO TEND TOWARD SOME TYPE OF ZONATION RESTING ON THE HIGH AND LOW PRESSURE AREAS:

1. The equatorial low pressure zone should produce high precipitation as it does today.
2. Deserts could be expected to develop between 15° and 35° north of the equator caused by the subtropical high. Mid latitude deserts would tend to develop in the east central portion of the westerly zone.
3. In the absence of mountain barriers the portions of the continents facing the prevailing westerlies should receive abundant moisture.

C. MONSOONAL CONDITIONS COULD BE EXPECTED TO DEVELOP ON THE SOUTHEASTERLY PORTIONS OF THE CONTINENTS (in the northern hemisphere).

D. WINTERS COULD BE EXPECTED TO BE MORE SEVERE ON THE POLEWARD SIDE OF CONTINENTS even in the absence of ice caps.

Although this general picture is probably valid there will always be modifications due to geographic factors such as the changing relations of land and sea, the rise of mountain chains and the influence of ocean currents. These factors can be very important and their effect on the present climate of the earth is well known; however, the effect of change in latitude must always be present and the basic pattern must persist even if modified.

The construction of the climatic zones for a hypothetical continent in a nonglacial period is shown in Fig. 1 (after Finch and Trewartha, 1949); therefore, if the approximate outline of a continent is known with its probable latitude, a reasonable reconstruction of its climatic zones is possible for a geological period. The paleogeography of some continents is known in its essential parts and the study of paleomagnetism gives the approximate latitude. Thus the major components are present for reconstructing past climates.

Using the procedure outlined above the writer has attempted to reconstruct the climatic zones of North America for the Pennsylvanian (Upper Carboniferous), Permian and Triassic and for the Permian of Europe. Relatively good paleogeographic maps exist for North America for the periods under study and for Europe during the Permian, Schuchert, 1955; Eardley, 1951; H. Termier and G. Termier, 1952. No attempt has been made to divide the periods into the different stages and the maps show the maximum extent of the epicontinental seas for these periods. The writer does not contend that these maps are extremely accurate but they do show the relative position of land and sea. The first map series (indicated with A1, A2 etc) shows the probable climatic zones for the different periods with the continents oriented as they are at the present and the second series (indicated with B1, B2 etc.) shows the climatic zones that follow from the orientation of the continents which is suggested by paleomagnetism.

On these maps have been placed the locations of occurrence of sediments which the writer believes to have paleoclimatic significance. These are:

1. Bauxite, tropical or subtropical climate with high temperature and possibly seasonal rainfall (Harder, 1949).
2. Evaporites, high temperature causing high rates of evaporation coupled with low precipitation.
3. Coal, adequate precipitation.
4. Bioherms, high water temperature, causing super saturation of sea water with $CaCO_3$ which allows rapid biochemical fixation of calcium carbonate (Rankama and Sahama, 1950).

Also shown on these maps are:

5. Direction of dominant wind determined by studies of eolian dune sands. Usually representing sand dune action in desert areas (Opdyke and Runcorn, 1959).
6. Direction of dominant wind predicted by the orientation of the continent.

The discussion of the different periods covering the reconstructions based on the two different orientations will start with the Permian of Europe.

Figure A.1 shows the hypothetical climatic zones for Europe during the Permian given its present latitude. If Europe lay in the same latitudes that it does at the present the continent would remain largely in the zone of the mid latitude westerlies. These westerly winds would tend to bring abundant moisture in from the Atlantic Ocean much as it does today. However, in the absence of ice caps the continent would probably be much warmer then it is at present. The subtropical zone may have extended farther north then the position shown on the map, but the fact remains that western Europe would remain in an area of abundant moisture.

Figure B.1 shows Europe oriented as indicated by paleomagnetism (Shove, Nairn and Opdyke, 1958). Most of Europe remains in the northern hemisphere; however, it is now almost entirely in the tropical zone. The hypothetical reconstruction of the climate is shown. It is immediately apparent that the most important difference between A.1 and B.1 would be the predicted appearance of a Permian desert in western Europe due to the shift of wind from the west to the east.

The climatic evidence from the Permian of Europe would seem to support the second orientation overwhelmingly:

1. The large evaporite basins of the Urals and northwestern Europe.
2. Development of reefs in England, Belgian and Russia, indicating tropical water temperatures.
3. The wind direction deduced from dune bedded sandstones in Great Britain agrees with the expected wind direction (Shotten, 1956).
4. Permian coals which would hardly have formed in an arid climate would reasonably occur in a position closer to the equator then the evaporites.

Next we turn to the Triassic of North America. Figure A.2 shows North America oriented in its present position. Most of North America would be dominated by the westerly winds bringing moisture to the west coast and, in the absence of a mountain barrier in Triassic times, would bring moisture into the interior. A mild moonsoonal regime would probably be established in the southeast bringing a seasonal aspect to the precipitation in this part of the continent.

Figure B.2 shows North America oriented as indicated by paleomagnetism (Du Bois et al.,1957). Most of North America remains in the northern hemisphere but approximately 30^{o} closer to the equator than it is at present. Thus most of North America would lie in the cone of the northeasterly trades. This would cause a belt of rainfall to the south with an arid climate developing in the west central portion of the continent.

The climates of the North American Triassic as deduced from the sedimentary indicators would seem to favor the climatic pattern presented in B.2:

1. The development of thick evaporites in Alberta (700 ft.) and thinner evaporites in the Wyoming shelf area (Hunt and Ratcliff, 1959; Krumbein, 1951).
2. Development of Triassic desert sand dunes in Arizona, Utah, and Colorado indicating a dominant northerly wind (Poole and Williams, 1956).
3. Triassic coals in Virginia and North Carolina indicating abundant moisture.
4. Existence of bioherms in Nevada indicating conditions of warm water (Twenhofel, 1950).
5. Evaporites in southern Mexico possibly indicating conditions of aridity south of the Triassic equator (Benavides, 1956).

The Permian of North America will be considered next. Figure A 3 shows the probable climatic zones based on the present orientation of North America. Conditions as shown are much the same as those given in Figure A.2 for the Triassic. Figure B. 3 shows North America oriented as suggested by paleomagnetism (Runcorn, 1956). Most of North America would seem to lie in the tropical zone between 30^{o}N abd 30^{o}S. The zonation corresponding to this position is given.

The climatic indicators from the Permian seem to indicate warm, arid conditions:

1. The Permian reef complex of the West Texas basins.
2. Evaporite deposition in Kansas, Oklahoma, Texas, New Mexico and Arizona.
3. Desert dune sandstone in Arizona and Wyoming indicating a north or northwest wind (Reiche, 1938).

It can be seen that neither of the proposed climatic schemes fit the distribution of the climatic indicators precisely. The wind direction deduced from the Coconino sandstone of Arizona could be a result of the northeasterly trade wind if the paleomagnetic data were slightly in error. This is a possibility because the results are mainly from one formation; e.g. the Supia formation (L. Perm.). Also the arid zone in the Southwest could possibly be a wind shadow effect of the mountains formed in the Appalachian Orogeny (8); however, it is concluded that A.3 and B.3 could both lead to the arid conditions which existed at this time in the western United States.

The Pennsylvanian paleogeography oriented in the present position of North America, Figure A.4, should lead to warm humid conditions penetrating deep into the middle of the continent under the influence of the prevailing westerlies with the subtropics extending farther toward the north than they do at the present.

The orientation of the continent suggested by paleomagnetism (Runcorn, 1956) on the other hand would place most of the continent again within the tropical zone with the equator passing diagonally across the continent from Newfoundland to the Gulf of California. This orientation would place most of the continent north of the equator in the path of the northeast trade wind and that portion of the continent remaining south of the equator would be influenced mainly by the southwest trades. A belt of high precipitation should run diagonally across the continent, being

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(8) The APPALACHIANS represent a mountain belt in the eastern U.S.A. and Canada along the Atlantic Coast, mainly formed during a period of mountain building at the end of the Carboniferous and during the Lower Permian (so called Hercynianfolding period of Europe).

broader in the east and narrow in the west. Arid conditions could be expected to develop in the west central part of the country caused by the easterlies having to cross the bulk of the continent.

The sedimentary climatic indicators present in the North American Pennsylvanian are:

1. Large amounts of coal formed in the east and east central part of North America. Indicating abundant rainfall in these areas.
2. Bauxite occurs in Pennsylvania and Missouri indicating tropical conditions for these regions (Harder, 1949).
3. Bioherm development in Texas indicating conditions of warm water (Bergenbeck and Terrierre, 1953).
4. Evaporites developed in the Black Hills region, the Gypsum basin Colorado and the Paradox basin Utah, the latter containing 4000 ft. of evaporites (Krumbein, 1951).
5. Dune bedded sandstones in Wyoming, northeast Utah and northwest Colorado show, on the basis of cross-stratification studies, that the depositing wind was dominantly a northeast wind (Opdyke and Runcorn, 1959).

We can see from a comparison of Figures A.4 and B.4 that the distribution is consistent with B.4 and not A.4. For B.4 predicts warm, humid conditions in eastern and northeastern North America and increasing aridity in the West, whereas A.4 does not indicate any aridity in the West. The direction of the dominant wind given above is also consonant with B.4. It might be noted that the areas of the greatest accumulation of evaporites in the Paradox and Gypsum basins would lie on the wind shadow of the Uncompagnian and Colorado Range positive areas if the wind was from the east but not if it was from the west. Thus being more consistent with the orientation derived from paleomagnetism.

CONCLUSIONS

If the theories concerning paleomagnetism are correct then this new branch of the earth sciences offers a means of determining lines of latitude independent of paleoclimatic study. Given these determinations in combination with paleogeographic studies it should be possible to reconstruct a hypothetical scheme of climatic zonation based on climatic principles known at the present time. This has been attempted in figures B.1 to B.4. It has been shown that these reconstructions fit the known distribution of certain climatic indicators in three of the four cases studied in detail. It is apparent that this method can be used to test whether the continents have remained stable in their present position or have moved relative to the poles as suggested by paleomagnetism. The results obtained support the paleomagnetically determined positions of the continents.

The author realizes that the reconstruction of the climatic belts herein presented can only be tentative but with an increase in the knowledge of paleogeography and more precise determinations of pole positions with the growth of paleomagnetism refinement in detail may be attempted. If accurate reconstructions of climate in the past are finally obtained it will be of great assistance to paleoecological and paleo-bioclimatological studies and may help us to explain the observed geographical distribution of plants and animals through geologic time.
It is the hope that this paper will stimulate more thinking along these lines.

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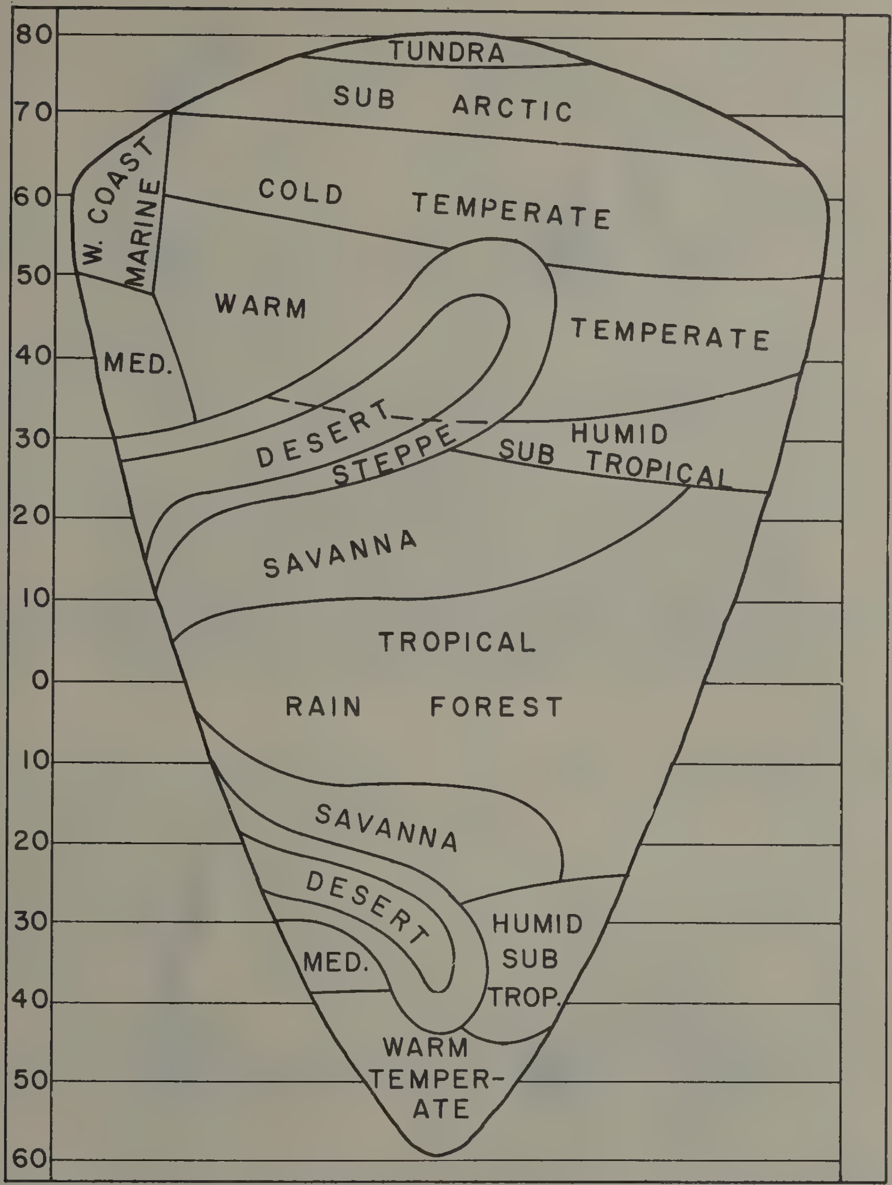
ABSTRACT

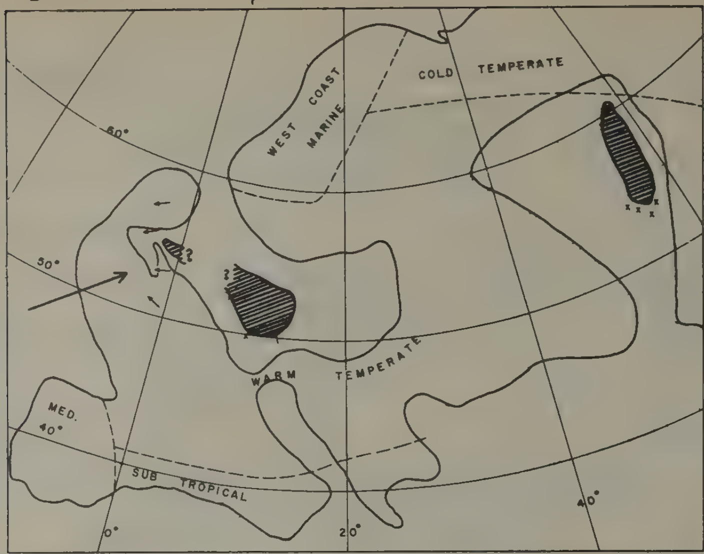
Paleomagnetism presents the paleo-bioclimatologist for the first time with an independent determination of latitude. In combination with paleogeography a reconstruction of climatic zones for the geologic periods can be attempted by taking into account the principles underlying the present distribution of climate. This was attempted for the Permian of Europe and the Triassic, Permian and Pennsylvanian (U. Carboniferous) of North America. An extension of this method can be of great importance in future paleo-ecological and bioclimatological studies if the underlying principles of Paleomagnetism prove to be correct.

Fig. 1



The climatic zonation of a hypothetical continent in a nonglacial period (Modified from Finch and Trewartha 1949)

Fig. A.1

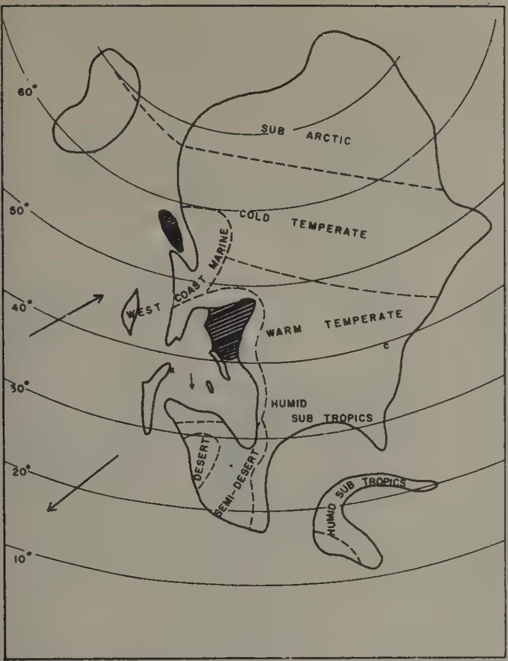


The paleogeography and climatology of the Permian of Europe, oriented as it is at present. In the different figures the large arrow shows the presumed dominant wind direction, the small arrows show the dominant wind direction as deduced from cross-stratification studies of aeolian sandstones, the cross-hatching shows areas of evaporite deposition, the "C" designates the accumulations of coal and "X" represents reef development, "O" represents accumulations of bauxite.

Fig. B.1

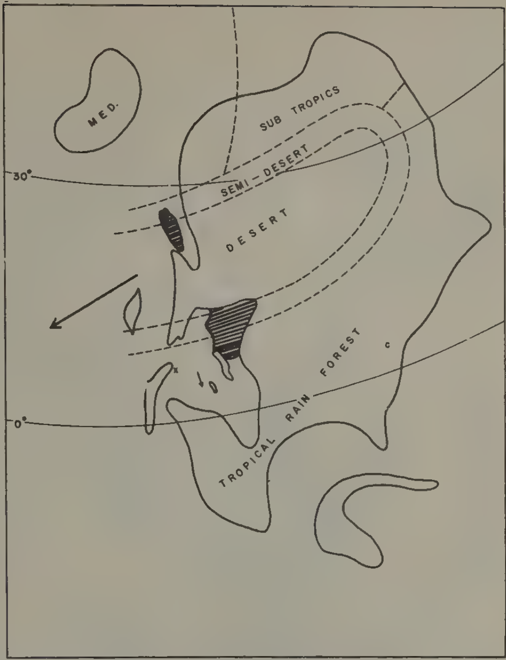
The paleogeography and climatology of the Permian of Europe, oriented as indicated by paleomagnetism.

Fig. A.2



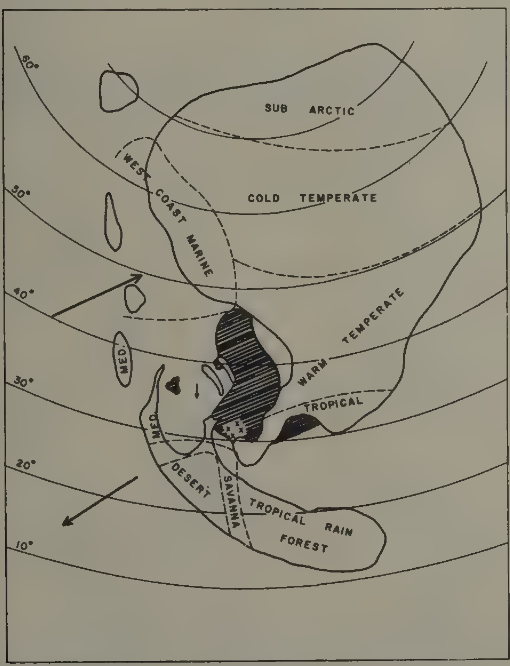
The paleogeography and climatology of the Triassic of North America oriented as it is at present.

Fig. B.2



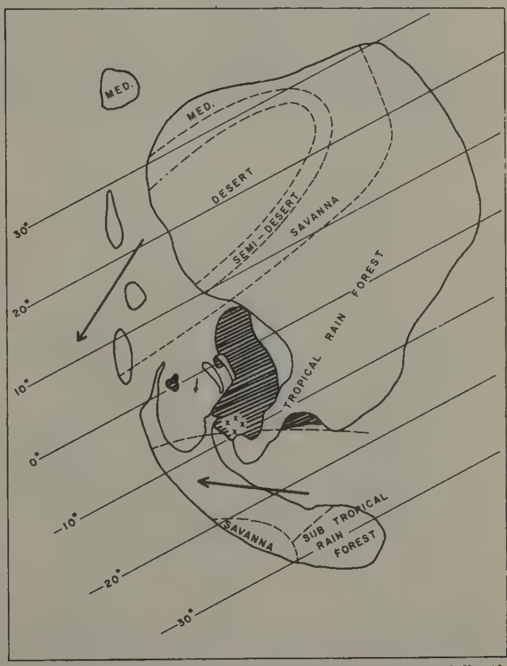
The paleogeography and climatology of the Triassic of North America oriented as indicated by paleomagnetism.

Fig. A.3



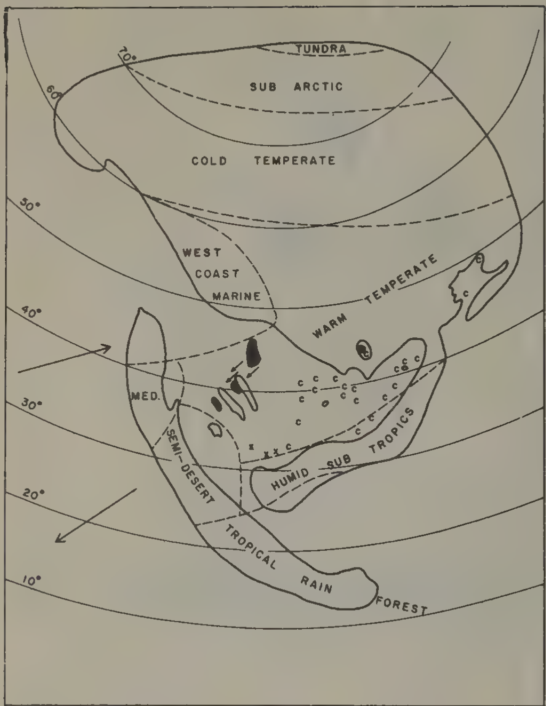
The paleogeography and climatology of the Permian of North America oriented as it is at present.

Fig. B.3



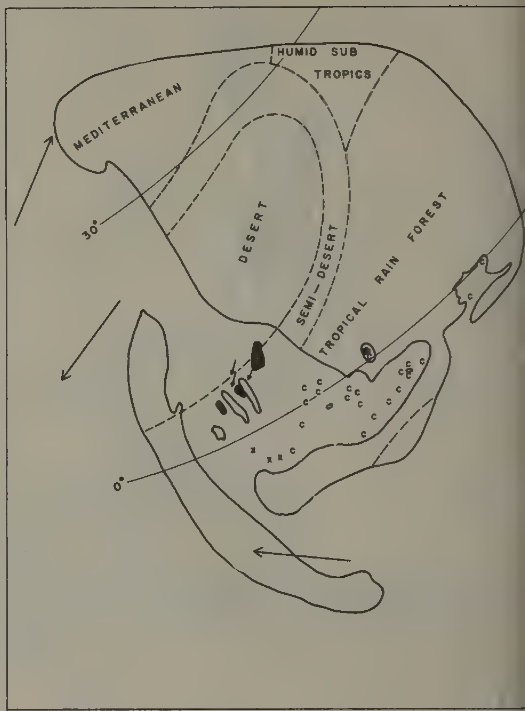
The paleogeography and climatology of the Permian of North America oriented as indicated by paleomagnetism.

Fig. A.4



The paleogeography and climatology of the Pennsylvanian of North America oriented as it is at present.

Fig. B.4



The paleogeography and climatology of the Pennsylvani of North America oriented as indicated by paleomagnetis

I.J.B.B., Vol. III, 1959, part VI, Sect. A

ANNEX TO ARTICLE OF Dr. N.D.OPDYKE

STRATIGRAPHICAL COLUMN OF THE EARTH

compiled by

Dr. S.W. Tromp

Age based on radioactive measurements compiled by Kovarik, Holmes, Moore a.o.

Distances between periods on real scale except Quaternary and pre-Cambrian

Age in years	Era	Period	Epoch	Stage	Plant development	Animal development	Orogenetic movements	Glaciation
271,000,000 - 309,000,000	PALEOZOIC (368,000,0…	CARBONIF…	Kohlenkalk=Dinantian=Kulm (Europe) or Mississippian (prod.) (38)	Tennesseian (U.S.A.)	Age of spore-bearing… Rise of landplants, first forests	Age o… Culmination of Crinoids (Camerata)		
				Waverlian (U.S.A)				
309,000,000 - 354,000,000		DEVONIAN (45)	Old red	Famennian or Chautauquan		Age of fishes →Ancestor of Amphibians		
				Frasnian or Senecan				
			Orcadian	Givetian or Erian				
				Eifelian or Ulsterian				
			Caledonian	Coblentzian or Oriskanian				
				Cedinnian or Helderbergian				
354,000,000 - 381,000,000		SILURIAN (94)	Gothlandian (27) SALOPIAN	Downtonian or Monroean	Age of sea-weeds	Age of invertebrates; Abundance of Brachiop. & Tetracoralla	Caledonian folding	glaciation uncertain
				Ludlow or Salinan				
				Wenlock or Niagaran				
				Llandovery or Alexandrian				
381,000,000 - 448,000,000			Ordovician (67)	Caradoc — Cincinnatian		Culmination of Trilobites and Graptolites; First appearance of fishlike vertebrata		
				Llandeilo — Mohawkian or Champlainian				
				Arenig — Canadian				
				Tremadoc				
448,000,000 - 553,000,000		CAMBRIAN (105)	Upper = Potsdamian	Ozarkian		Dominance of Trilobites; rise of primitive cephalopods; First abundant invertebrate fossils (1 Trilob; 2 Brachiop; 3 Gastrop.)		
				Croixian				
			Middle = Acadian = Menevian					
			Lower = Georgian = Taconian = Waucobian					
553,000,000 - 2,000,000,000	PROTEROZOIC or PRE-CAMBRIAN (no true vert. scale)	Algonkian or late Proterozoic (900)	Keweenawan	Jotnian	Remains of life mostly lacking, primitive algae		Epijatulian folding	
			Animikian	Jatulian				
			Huronian				Huronian folding	
			Sudburian	Kalevian				
		Archeozoic or early Proterozoic (>500)	Laurentian				Pre-Laurent folding	
			Keewatin					
			Coutchiching					

CONTINUATION OF STRATIGRAPHICAL COLUMN

AGE IN YEARS	ERAS (TOTAL AGE IN YEARS)	PERIODS (TOTAL AGE IN MILLION YEARS)	EPOCH	STAGE	main characteristics of plant development	main characteristics of animal development	main Orogenetic movements	main periods of glaciation
0 - 2,000,000	CENOZOIC (60,000,000)	QUATERNARY (2) (NO TRUE VERT. SCALE)	Alluvium or Holocene	Post glacial (20,000 - 10,000)	Age of modern seed plants (angiosperms)	Age of man		
			Diluvium or Pleistocene (1,900,000 - 20,000 B.C.)	IV Würm glacial or Wisconsin (40,000 - 20,000 B.C.)				Glaciations particularly of N. Europe and N. America
				3rd Intergl. or Sangamon				
				III Riss glacial or Illinoian				
				2nd Intergl or Yarmouth				
				II Mindel glacial or Kansan				
				1st Intergl or Aftonian				
				I Gunz glacial or Nebraskan				
2,000,000 - 60,000,000		TERTIARY (58) — Neogene	Pliocene (abt. 2,000,000 - 12,000,000 B.C.)	Upper — Sicilian	Rise of modern floras	Age of higher mammals (placentalia); Beginning of man	Alpine folding	
				Middle — Astian				
				Lower — Plaisancian				
			Miocene	Upper — Pontian		Culmin. of mammals		
				Middle — Vindobonian				
				Lower — Burdigalian				
		Palaeogene	Oligocene	Aquitanian or Chattian		Culm. & extinct of archaic mam.		
				Stampian or Rupelian				
				Lattorfian or Tongrian				
			Eocene	Upper — Priabonian		Rise of mammals & teleosts		
				Middle — Bartonian				
				Lutetian				
				Lower — Ypresian, Palaeocene				
60,000,000 - 125,000,000	MESOZOIC ('125,000,000)	CRETACEOUS (65)	Upper — Laramian	Senonian — Maestrichtian	Rise of flowering plants	Age of giant reptiles and ammonites; Last dinosaurs, Pterodactyls & ammonites, Large marine rept., toothed birds, modern insects		
				Campanian				
				Santonian				
				Turonian				
				Cenomanian				
			Lower — Neocomian (=Wealden = Comanchean)	Albian (=Gault)				
				Aptian				
				Barremian (=Urgonian)				
				Hauterivian				
				Valanginian				
125,000,000 - 157,000,000		JURASSIC (32)	Upper (Malm)	Portlandian	Age of Cycadophytes	Rise of toothed birds, culmin. of Ammonites		
				Kimmeridgian				
				Lusitanian				
				Oxfordian				
			Middle (Dogger)	Callovian				
				Bathonian				
				Bajocian				
			Lower (Liassic)	Toarcian				
				Charmouthian				
				Sinemurian				
				Rhetian				
157,000,000 - 185,000,000		TRIASSIC (28)	Keuper	Norian	Age of Coniferophyta	Rise of Dinosaurs, Pterodactyls, marine reptiles, Lower mammals (aplac.), first Hexacoralla		
				Carnian				
			Muschelkalk	Ladinian				
			Buntsandstein	Anisian				
				Werfenian				
185,000,000 - 223,000,000		PERMIAN (38)	Zechstein	Thüringian	Age of ancient seed plants (gymnosperms)	Rise of primitive Reptiles, last Trilob. Tetracoralla	Hercynian or Variscian fold.	Glaciation of large parts of S. Hemisphere
			Rotliegendes	Saxonian				
				Artinskian				
223,000,000 - 271,000,000	…o)	…EROUS (86)	Product. Carb. (Europe) or Pennsylvanian (48)	Stephanian (W. Europe) — Ouralian	…plants; Culmination of spore-b. plants	…f amphibians; Spread of amphibians, First insects (cockroaches) 1st Reptiles		
				Westfalian (W. Europe) — Moscovian				
				Namurian (W Europe)				

COSMIC BIOCLIMATOLOGY
Section A: General Cosmic Bioclimatology

BLOOD CLOTTING TIME UNDER METAL COVER (BIOLOGICAL P-TEST)

by

Prof.Shinji Itoh, Keisuke Tsujioka and Hiroo Saito (Japan)*

Inorganic colloid systems are greatly influenced by various environmental conditions. To determine extra-terrestrial factors which may affect the colloid reactions, Piccardi (1) proposed a test method entitled the "CHEMICAL TEST".**

For this purpose he used the formation of insoluble bismuth oxychloride which is produced by the hydrolysis of bismuth chloride. In his "P-test", the reaction is observed under two different conditions: one in a metal-free room and another in a room where it is completely covered by a thin copper sheet 1 mm thick. Each pair of experiments is carried out simultaneously inside and outside a copper box and the rate of precipitation compared. If the formation of the colloidal precipitation of bismuth is faster inside than outside of the box, it is recorded as "T". The result of ten measurements is expressed as T per cent. Piccardi also measured the clotting time of human blood inside and outside the copper box, and found that the time is always longer inside than outside (2). He called this clotting reaction under a copper sheet "BIOLOGICAL P-TEST". However, this conclusion may not be acceptable. If T per cent is high, clotting time inside the box should be shorter than that outside of the box. His experiments were carried out in Florence during August 1955, when T per cent throughout the month was below 50 per cent. (1) This might be the reason why he obtained such a one-sided result. To clarify this problem we measured the clotting time of rabbit blood by the method of Sahli and Fonio inside and outside a copper box simultaneously. The ratio of the time outside/inside was compared with T per cent which was determined at the same time. One hundred observations were carried out during a period from November 1958 to June 1959. The results are illustrated in Fig. 1.

Though individual values fluctuated considerably, the mean value of each group showed a consistent tendency: a low ratio of the clotting time when the T per cent was low and vice versa. That is, when the rate of colloidal precipitation of bismuth is slower in the copper box than outside of it, the clotting time of blood is also slower in the box. Statistical analysis indicated that the results are highly significant. Thus, the "BIOLOGICAL P-TEST" is proven to be correlated with the inorganic P-test.

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** For further details see Int. Journal of Biocl. and Biomet., vol. II, 1958, Part V, sect. A.

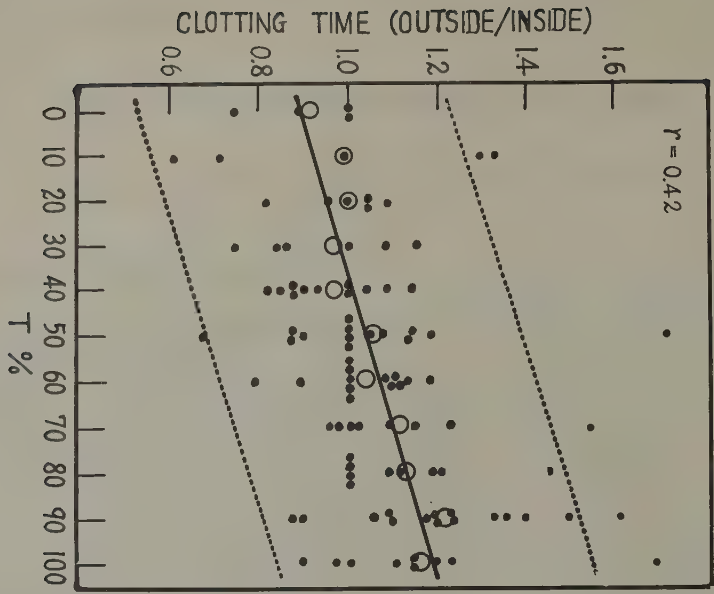

Fig. 1 Relationship between the ratio of the clotting time (outside/inside) and T per cent of P-test. White circles represent mean values of the clotting time ratio for each group of the T% values.

Section B : Special cosmic bioclimatology

Section C : World literature

PART VI

PALEO-BIOCLIMATOLOGY

(1959)

PALEO-BIOCLIMATOLOGY

Section A : General paleo-bioclimatology

Section B : World literature

PART VII

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Scientific Committees of the Society
Symposia or Congresses
Bioclimatological Stations and Institutions
Requests from Members
Requests from non-members
Book Reviews
International Organizations
Advertisements

(1959)

Section A : Scientific committees of the Society

1. Reports
   a. Allergic diseases
   b. Ecological climatography
   c. Instrumentation
   d. Ionisation of the air
   e. Nautical bioclimatology (general-, cargo bioclimatology)
   f. Chemical tests
   g. Tropical bioclimatology
   h. Solar Radiation
2. Literature

Section B : Symposia or congresses of international organizations and of national bioclimatological societies (dates, programmes, summaries of important lectures, decisions, etc.)

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section B: Symposia of Bioclimatological Societies

SYMPOSIUM INTERNATIONAL SUR LES RELATIONS ENTRE PHENOMENES SOLAIRES ET TERRESTRES EN CHIMIE-PHYSIQUE ET EN BIOLOGIE *

A l'initiative du PROFESSEUR G. PICCARDI, Directeur de l'Institut de Chimie physique de l'Université de Florence et sur l'invitation du PROFESSEUR P. BOURGEOIS de l'Université de Bruxelles, Directeur de l'Observatoire Royal de Belgique, un Symposium international s'est tenu à l'Observatoire Royal de Belgique, à Uccle, les 8, 9 et 10 octobre 1958.

Il était agréé par le Commissariat Général du Gouvernement près l'Exposition Universelle et Internationale de Bruxelles 1958.

I. LE BUT DU SYMPOSIUM

Le but de ce Symposium était essentiellement un examen critique et une synthèse des observations effectuées depuis 1950 par la METHODE DIFFERENTIELLE ET STATISTIQUE DU PROFESSEUR PICCARDI.

Les hypothèses interprétatives des fluctuations périodiques, observées en fonction du temps, dans les résultats de divers tests physico-chimiques inorganiques, lient celles-ci à l'activité solaire et au mouvement de la Terre dans la Galaxie. Une interprétation relativiste d'une certaine fluctuation annuelle a été présentée comme une conséquence d'une théorie générale de la gravitation universelle.

Le rapprochement de ces observations avec celles d'ordre biologique ou médical qui mettent en cause l'influence de facteurs atmosphériques ou cosmiques ouvre une perspective nouvelle dans l'étude de ces facteurs et de leurs effets pathologiques ou sociaux.

L'exposé introductif du Professeur Piccardi situe la portée des problèmes abordés sur le plan philosophique et humain. Il souligne notamment l'importance essentielle d'ordonner en fonction du temps les résultats d'un grand nombre d'observations semblables. La prise en considération de la variable temps, peu habituelle dans les expériences physico-chimiques de laboratoire, a permis de donner un sens aux résultats statistiques non reproductibles d'un ensemble d'expériences apparemment identiques.

Les causes de cette non-réproductibilité apparaissent ainsi liées à la variabilité des conditions physiques de l'espace environnant, qui, dans la plupart des conditions expérimentales usuelles, échappe à tout contrôle.

Ceci met en question, aussi bien dans certains domaines de la physico-chimie et de la biologie que de la médicine et de la sociologie, des critères de validité admis sans conteste jusqu'ici, dans les méthodes expérimentales d'investigation scientifique.

II. OBJET DES COMMUNICATIONS ET DISCUSSIONS

PROF.G. PICCARDI (Directeur de l'Institut de chimie physique de l'Université de Florence): "EXPOSE INTRODUCTIF"

Cet exposé introductif apporte, en dehors des considérations générales déjà indiquées, un aperçu des systèmes sensibles aux facteurs météorologiques ou cosmiques, dans un bref historique du développement des recherches.

Il souligne particulièrement l'importance biologique, parmi ceux-ci, de l'eau et des systèmes colloïdaux.

Il évoque finalement les liens qui rattachent le thème des discussions du Symposium à celui "....pour un monde plus humain", de l'Exposition Universelle et Internationale de Bruxelles 1958,

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* Prepared by Prof. G. Piccardi, Director Istituto di Chimica Fisica, Via Gina Capponi 9, Firenze, Italy.

qui a accordé son patronage à la réunion. Il en conclu: "C'est seulement en sachant par quel mécanisme il est lié à la terre et au ciel, que l'homme pourra comprendre mieux sa position physique et psychique dans l'Univers d'aujourd'hui".

PROF. G. PICCARDI: "LES TESTS CHIMIQUES"

Le professeur Piccardi expose ensuite le principe de la méthode des "tests chimiques" et les résultats de toutes les observations faites par cette méthode à Florence. Ceux-ci mettent remarquablement en évidence, sur une réaction d'hydrolyse, une fluctuation annuelle superposée à une variation séculaire qui a pu être statistiquement rattachée à l'activité solaire.

Ils montrent aussi la grande sensibilité de l'eau et des systèmes colloidaux instables à l'action de divers facteurs physiques naturels ou artificiellement appliqués, les conditions différentielles et statistiques propres à la méthode, exclant les effets directs bien connus de la température ou de la pollution des réactifs.

MME. C. CAPEL-BOUTE (Fac. des Sciences Appliquées de l'Université de Bruxelles): "OBSERVATIONS SUR LES TESTS CHIMIQUES DE PICCARDI EFFECTUEES A BRUXELLES DE 1950 à 1958"

Mme C. Capel-Boute apporte la confirmation du caractère général des facteurs influençant cette réaction d'hydrolyse, par les corrélations, étudiées statistiquement, entre des observations semblables faites simultanément à Bruxelles et à Florence. Celles-ci laissent prévoir cependant des effets météorologiques locaux ou des effets de latitude, variables selon la période du cycle de l'activité solaire.

Les possibilités et les limites de la méthode ont pu être discutées en fonction des conditions opératoires, celles-ci ayant été préalablement concrétisées pour les participants au Symposium, par la visite du laboratoire de Mme Capel, installé à l'Observatoire Royal de Belgique.

Dr. UDO BECKER (Frauenhofer Institut - Freiburg i.B.): "SONNENAKTIVITAET UND CHEMISCHE TESTS"

M.U. Becker présente l'étude des corrélations, statistiquement assurées, entre les résultats des tests chimiques obtenus à Florence et les caractères de l'activité solaire, taches et éruptions, dans leur variation séculaire. Cependant une périodicité annuelle dans les fluctuations des tests chimiques, apparaît sans relation avec l'importance des taches solaires. L'allure annuelle sinusoïdale de certains tests apparaît comme une variation saisonnière normalement liée à la position du Soleil tandis que l'allure annuelle moyenne, propre au test D, effectué dans une chambre faradisée en tôle de cuivre mince, exige une interprétation particulière.

PROF. G. PICCARDI: "UNE HYPOTHESE SOLAIRE"

Le Professeur Piccardi présente ensuite "l'hypothèse solaire" qu'il a proposée pour interpréter l'allure typique de la fluctuation annuelle du test D. Cette hypothèse repose sur la considération de la trajectoire hélicoïdale de la Terre dans la Galaxie, résultant de la combinaison de l'orbite elliptique de la Terre autour du Soleil, et de la translation du Soleil lui - même dans la Galaxie.

Un modèle matériel de ce mouvement résultant de la Terre à été présenté au Planétarium de Bruxelles dans la cadre de l'Exposition de 1958.

Dr. D. QUILGHINI (Institut de Mécanique rationnelle de l'Université de Florence): "LES ELEMENTS CINEMATIQUES DU MOUVEMENT DE LA TERRE REFERE AUX ETOILES FIXES".

L'étude mathématique de cette trajectoire, faite par M. Quilghini, montre une importante variation périodique de la vitesse et de l'orientation de la Terre le long de cette trajectoire. Celles-ci présentent notamment aux équinoxes de mars et septembre, des caractères particuliers vis à vis du champ galactique.

La nouveauté de cette hypothèse solaire consiste sans doute à appeler l'attention sur l'importance que pourrait avoir dans les fluctuations de certains phenomènes terrestres, les facteurs de champs, de rayonnement ou de déviation de particules d'origine solaire ou cosmique:

Elle pourrait conduire ainsi à une conception nouvelle des phénomènes saisonniers,restes traditionnellement rattachés jusqu'ici a la simple orbite elliptique de la terre autour du soleil.

PROF. A. GIAO (Ing. Géophys. Lisbonne-Paris): "INTERPRETATION RELATIVISTE DE LA VARIATION ANNUELLE DU TEST D PHYSICO-CHIMIQUE DE PICCARDI ET SA SIGNIFICATION COSMOLOGIQUE"

Il appartient au Dr. Giao de confirmer l'importance qu'aurait la variation de la vitesse de la Terre dans son mouvement hélicoïdal dans le champ galactique. Il démontre, en effet, mathématiquement, que la variation annuelle du test D physico-chimique de Piccardi, peut apparaître comme une conséquence de la théorie générale de la gravitation universelle qu'il a proposée antérieurement.

Les liens possibles étant ainsi établis entre des actions physiques de l'espace cosmique et certains phénomènes physico-chimiques d'importance vitale, leurs conséquences d'ordre biologique ou médical peuvent etre envisagées cette fois sous un angle nouveau.

PROF. H. BERG (Professeur de Météorologie et Géophysique à l'Université de Cologne): "SOLAR-TERRESTRISCHE BEZIEHUNGEN IN BIOLOGIE"

Le professeur Berg passe en revue nombre de corrélations tentées entre des observations biologiques ou médicales et des phénomènes solaires. Il en discute la valeur statistique souvent insuffisante, et critique différentes méthodes de corrélation employées dans ces recherches.
Il considère cependant la probabilité d'une influence directe ou indirecte de l'activité solaire sur certaines observations, notamment les effets biologiques liés à la coagulation du sang, comme sérieusement renforcée par les corrélations bien assurées établies entre l'activité solaire et les tests physico-chimiques de Piccardi.

Dr. F. VERING (Directeur du Bundesstaatliches Serumprüfungsinstitut de Vienne): "NACHWEIS EXTRATERRESTRISCHE EINFLUESSE AUF MIKROBIOLOGISCHE SYSTEME. EIN BIOLOGISCHER P-TEST"

Enfin, le Dr. Vering s'est efforcé de mettre en évidence l'influence de facteurs extérieurs spaciaux, en différenciant l'évolution d'un matériel biologique vivant, par l'action d'un écran métallique. La variabilité des résultats, soigneusement analysée en fonction des conditions opératoires pour discriminer les facteurs influençants, le conduit également à la nécessité d'une révision des conceptions expérimentales, et des principes de l'analyse causale, aussi bien dans certains domaines de la biologie, que de la médecine et de la sociologie.
Ces conceptions doivent tenir compte de la variabilité des facteurs incontrôlables qui déterminent l'irréversibilité du temps.

III. DISCUSSION GENERALE ET CONCLUSIONS

La discussion générale traite de l'importance des connaissances actuelles sur la structure de l'eau et de divers facteurs propres à la chimie colloïdale dans l'action de facteurs physiques sur l'eau et les solutions.
Elle souligne l'intérêt de recherches plus poussées sur la cinétique de coagulation et de sédimentation, prenant en considération la pureté des réactifs et les diverses actions physiques envisagées précédemment notamment celles de champs électromagnétiques de diverses fréquences, et celles d'écrans conducteurs ou non.
Elle porte encore sur l'importance relative des intensités de divers facteurs d'origine extérieure, par rapport à ceux mis en oeuvre au laboratoire, et sur la difficulté de réaliser des expériences "absolues" valables, plutôt que des essais différentiels et statistiques.

IV. COMPTE-RENDU DE LA REUNION DE LA SECTION EUROPEENNE DU COMITE INTERNATIONAL POUR L'ETUDE DES TESTS CHIMIQUES

La réunion du groupe européen du Comité International pour l'étude des tests chimiques, a examiné les conditions de développement des observations avec les tests chimiques aux diverses latitudes, au cours de l'Année Géophysique Internationale et après, grâce notamment à la collaboration active des institutions suivantes, du nord au sud:

BRUXELLES (Uccle)	: Laboratoire d'électrochimie et métallurgie de l'Université Observatoire Royal de Belgique.
JUNGFRAUJOCH	: Astronomisches Institut der Universität.
VIENNE	: Institut für Analytische Chemie der Technischen Hochschule Untertullnerbach (Oesterreich): Wiental-Wasserleitung.
GENES	: Istituto Geofisico e Geodetico dell'Università
TRIESTE	: Osservatorio Geofisico et Istituto Sperimentale Talassografico.
FLORENCE	: Istituto chimica fisica dell'Universtità
CASTELLANA GROTTE (di Bari)	: 2 stations (intérieur et extérieur de la Grotte)
LIBREVILLE	: Service Météorologique du Gabon.
LEOPOLDVILLE	: Service Météorologique du Congo Belge
FORT DAUPHIN	: Service Météorologique de Madagascar
ILES KERGUELEN	: Méteorologie Nationale Française
SAPPORO	: Département de physiologie de l'Université de Hokkaido (Japon).
KUMAMOTO	: Département de physiologie et d'hygiène de l'Université (Japon).

Il s'y ajoute actuellement une station à la BASE ROI BAUDOUIN DES EXPEDITIONS BELGES DANS L'ANTARCTIQUE.

Les deux voeux suivants ont conclu la réunion:

1. Création d'un laboratoire central d'étude des "Tests chimiques" en vue de la recherche, de la mise au point et de-la standardisation des conditions opératoires les plus appropriées à l'étude des différents facteurs physiques en cause.
2. L'organisation systématique dans les observatoires ou instituts météorologiques adéquats, d'observations régulières au moyen des tests les plus faciles, soit à des heures déterminées, soit continûment.

Florence, 7 octobre 1959

Copies of the Proceedings can be obtained from the "Presses Académiques européennes", Chaussée de Charleroi, Bruxelles, Belgium. Price 200 Belgian Francs.

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section B: Symposia of National Societies

THE EFFECTS OF POLLUTION ON LIVING MATERIAL

by

Dr. J.L. Cloudsley - Thompson (Gr. Britain) *

The subject of the Institute of Biology's symposium for 1958 was one of interest to many members of the International Society of Bioclimatology and Biometeorology. Held in the Lecture Hall of the Royal Geographical Society, London, on 25-26 September 1958, the symposium comprised fourteen papers on various biological aspects of pollution. The first six of these were concerned with various aspects of water pollution and therefore do not come within the scope of this Journal; but most of the remainder dealt with the effects of air pollution on living organisms.

Hazards and nuisances of air pollution from the burning of coal have been recognised in varying degree since the thirteenth century, but in spite of technological improvements the basic problems of preventing the emission of smoke and sulphur fumes and of obviating the damage they cause, have remained unsolved. As Dr. E.T. Wilkins (Department of Scientific and Industrial Research) pointed out in a paper on chemical and physical effects of air pollution on living material, the use of coal in Britain at the present time amounts to about 200 million tons annually and some 20 million tons of oil are also consumed. The emissions of dust smoke and sulphur dioxide resulting from the use of these fuels have been estimated at 0.8, 2 and 5 million tons a year respectively. In addition, the concentration of carbon monoxide in petrol-engine exhausts is several hundred times the toxic limit, although the rate of dilution after leaving the exhaust pipe is extremely rapid. Drivers and passengers of cars and other vehicles may inhale as much as 130 p.p.m. of carbon monoxide, if not more, the effect of which might well be to slow the driver's mental reactions and make him more accident-prone. With regard to "smog", it has been shown that the daily mortality follows closely and with little time lag, the daily changes in pollution as measured by smoke and sulphur dioxide.

Dr. J.K.A. Bleasdale outlined the results of pollution on plant growth and described experiments showing the effects of pollution in reducing the effective light period per day. Tarry deposits on leaves further reduce the light available and gaseous pollutants also have these effects. Sulphur compounds play an important part in regulating cell division and Dr. Bleasdale suggested that they might effect the rates of litter-production and leaf-formation by rye grass.

The effects of atmospheric pollution on man were described by D.P.J. Lowther (Medical Research Council), who emphasised that the bewildering diversity and contradictions to be found in the vast literature relating to air pollution should not be allowed to diminish public anger and disgust at the tragic effects of the use of the air as a sewer.

In Britain, chronic fluorine poisoning or "fluorosis" occurs almost exclusively in animals in industrial areas, said Dr. Ruth Allcroft and arises from aerial contamination of herbage by the emission of fluorine-containing gases and dusts from industrial plants. The total economic loss occasioned is not great compared with that caused by other diseases, but is a matter of serious concern to farmers whose stock are affected. Dr. Allcroft illustrated her lecture with a film showing fluorine poisoning in cattle. The effects of this appeared to cause such acute agony and suffering to the wretched animals that surprise was expressed by members of the audience that such a disgraceful state of affairs should be tolerated.

The uptake of radioactive fission products by plants was discussed by Dr. H.J.M. Bowen, whilst their effect on aquatic organisms formed the subject of a paper by Mr. W.L. Templeton. The writer of this review was most impressed by the care applied by members of the Research and Development Branch of the United Kingdom Atomic Energy Authority to the establishment of safe levels of radioactivity in organisms that directly effect man.

Finally, a challenging and stimulating contribution by Dr. T.C. Carter (Medical Research Council's Radiobiological Research Unit) stressed the need for new experimental data on the nature of the radiation dose/mutation relationship in low dose ranges, in order that minimal criteria may be determined. At present this relationship is completely unknown in the case of mammals. Yet, if it is other than linear, the whole logical structure supporting present-day assessments of the genetical hazard to man of nuclear and allied radiations, collapses like a house of cards.

As in many previous Symposia of the Institute of Biology, the unfortunate dichotomy between purely scientific, economic and political motives was manifest. One could not help reflecting that the real difficulties are probably social and financial rather than biological, and present problems of ethics rather than of science.

The preceedings of the symposium will be published by the Institute of Biology, 41, Queen's Gate, London, S.W. 7.

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MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section B : Reports of Congresses of National Bioclimatological Societies

REPORT ON THE BIOCLIMATOLOGICAL CONFERENCE IN CIECHOCINEK (Poland) *
(30 - 31 October 1958)

A Bioclimatological Conference was held in Ciechocinek-Spa, 30 - 31 October 1958, during the 3rd Polish Congress of Balneology. The purpose of the Conference was to discuss the problems of bioclimatology in towns, industrial centres and health-resorts; and St. Zych delivered a paper on this subject.

Papers of a more general character were presented by St. Rózański - on the need for a climatic classification of health-resort areas and by S. Tyczka - on the problems on bioclimatological research and methods, mentioning the latest world publications.

The climate of towns was discussed in one paper only - The Bioclimate of Łódź- by St.Rózański, M. Tarajkowska and St. Zych. Various methods of research carried out in the area of this town were concerned first with constant gaseous atmospheric pollution and its noxious influence on human health and secondly on the flora of the region. The research made it possible for the climate of the town to be classified approximatively and areas convenient for flat-, service- and industrial buildings to be designated.

The problems of climate in health-resorts and their surrounding regions and of the influence of climate on man were discussed in the majority of the papers. W. Wójtowicz presented an account of the climate of the Kłodzko-Valley. Based on classical climatological materials over a 50 years' period, the author tried to give a bioclimatological interpretation of the climatic relations of the region. Five climatic zones were differentiated differing distinctly from each other in regard to the value and dynamics of their climatic factors as well as in their importance in therapy. The indication of vertical increase in precipitation allowed areas of relative tranquillity to be excluded. In his paper "The local climate of Polanica-Spa (Kłodzko Valley)", in addition to a short outline of the climate, M. Kołodziejek discussed the local differences of microclimate based on data from the local meteorological station from 1950 until 1957 as well as on regional measurements. Microclimatic differences denoted the health-resort areas most advantageous for future building and those requiring amelioration of the climate.

The paper by J. Cieślak on the duration of sunshine in Polanica-Spa and Kudowa-Spa in the years 1951 - 1957 is a valuable supplement to the climatology of the Kłodzko Valley. T. Szczęsna presented the results of research on the ozone content of the air close to the earth's surface in the area of Ciechocinek-Spa and A. Gurba the results of research on cooling-power in the same Spa on the base of catathermometric measurements carried out at the meteorological station during a five-year period.

S. Liman described the result of microclimatic research in galleries and cavities of the salt-mine at Inowrocław, a possible site for the future treatment of asthmatic patients. The differences in temperature and humidity as well as in air movement are rather great, depending on distance from the shaft, on the presence of water and on the working of ventilators.

M. Kwaśniewska-Błaszczyk in her paper "The Groer-Hecht reaction in children during health resort treatment on the Baltic seashore (Kołobrzeg-Spa)" and J. Jez and H. Chobot in theirs "On the behaviour of the bacterial flora in the nasopharynx of children under the influence of thalassotherapy" tried to explain the influence of climatic conditions on the phenomena.

W. Gądzikiewicz considered air movement in some Polish health-resorts as an indispensable factor in denoting the "effective temperatures". In the papers of B. Kiełczewski and J. Bogucki the results are given of preliminary research on the influence of cosmo-meteorological factors on some physiological functions of the organism in rest and after activity tests.

Physical bioclimatology was discussed in several papers. J. Słomka delivered one on atmospheric extinction in Wrocław during the years 1950-1955. The author reached the conclusion that in an annual cycle the reduction in solar radiation in the atmospheric layer close to the earth's surface - even in the big towns - is insignificant in comparison with its reduction in the whole atmosphere. M. Kluge discussed the results of research on the influence of atmospheric pollution

* Report prepared by mgr Władysław Wójtowicz, Instytut Balneoklimatyczny, Poznań, Poland.

on the reduction in direct solar radiation in the industrial centre of High Silesia. J. Paszyński referred to the results of research on the transparency of the atmosphere carried out during a sea voyage from Vietnam to Poland. M. Cena and J. Słomka presented a map of bioclimatological dry and humid cooling power in Poland calculated with the empirical formulae of Hill and Lehmann on the basis of data from 50 Polish meteorological stations. The authors compared the results with those obtained by other authors in other areas and discussed from a biological and climatological point of view the value of the results obtained. W. Bogusławski presented insolation tables for Poland and discussed some biophysical aspects of colour vision.

TITLES OF PAPERS READ AT THE BIOCLIMATIC CONFERENCE IN CIECHOCINEK *

GENERAL THEMES:

1.	St. ZYCH	– Research into the bioclimates of towns and industrial centres and health resort treatment.
2.	St. RÓZAŃSKI	– The necessity for climatic classification in health resort's areas.
3.	S. TYCZKA	– The problems, research methods and perspectives of development in human bioclimatology.

BIOCLIMATOLOGY OF TOWNS AND OF HEALTH RESORTS:

4.	St. RÓZAŃSKI M. TARAJKOWSKA St. ZYCH	– The bioclimate of Lódź.
5.	W. WÓJTOWICZ	– The climate of the Kłodzko valley.
6.	M. KOŁODZIEJEK	– The local climate of Polanica-Spa.
7.	L. CIEŚLAK	– The duration of sunshine in the spas of Kudowa and Polanica.
8.	T. SZCZESNA	– Research on the ozone content of the atmospheric layer close to the earth's surface in the area of Ciechocinek-Spa.
9.	A. GURBA	– Catatermometric cooling power in Ciechocinek-Spa
10.	W. GĄDZIKIEWICZ	– Air movements and wind in Spas and Rest centres in Poland.
11.	S. LIMAN	– Microclimatic research in galleries and cavities of the salt – mine Solno I in Inowrocław.

MEDICAL BIOCLIMATOLOGY:

12.	M. KWAŚNIEWSKA-BŁASZCZYK	– The Groer-Hecht reaction in children during health-resort treatment on the Baltic Seas.
13.	H. CHOBOT	– On the behaviour of the bacterial flora in the naso-pharynx of children under the influence of thalassotherapy.
14.	B. KIEŁCZEWSKI	– The results of introductory ecological research on the influence of cosmo-meteorological factors on some physiological functions of human organism in rest and after activity tests.
15.	J. BOGUCKI	– Research on changes in physiological functions dependent on cosmo-meteorological factors based on research carried out in training camps of the Higher School for Physical Education, Poznań.

PHYSICAL BIOCLIMATOLOGY:

16.	M. CENA J. SŁOMKA	– The bioclimatic cooling power in Poland.
17.	J. SŁOMKA	– Atmospheric extinction in Wrocław during the years 1950-55 (bioclimatic aspects).
18.	M. KLUGE	– The influence of atmospheric pollution on the effect of solar radiation in a High Silesian Industrial Centre.
19.	J. PASZYŃSKI	– Research into atmospheric transparency during oceanic voyage; introductory results of direct measurements of solar radiation.
20.	W. BOGUSŁAWSKI	– The iso-insolar table indexes of Poland.
21.	W. BOGUSŁAWSKI	– On some biophysical aspects of colour vision, decomposition of solar-radiation and colour vision.

* Compiled by mgr. Stefan Liman, Instytut Balneoklimatyczny, Poznań, Poland.

MISCELLANEOUS BIOCLIMATOLOGICAL DATA
Section B: Reports of Congresses of national bioclimatological societies

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PROGRAM OF THE BIOCLIMATOLOGICAL CONFERENCE AT LIBLICE (CZECHOSLOVAKIA) (3-5 November 1958) *

PICKO, V. (Hygienisches Institut, Praha): Singularität und Morbidität (Unsere Erkenntnisse vom Einfluss und Manifestation der Singularität auf die Entwicklung und den Verlauf der Morbidität).

TROMP, S.W. (Bioclimatological Research Centre, Leiden): Review of Bioclimatological studies carried out at the Bioclimatological Research Centre at Leiden (Netherlands).

BARCAL, R. and BOBEK, K. (Interne Klinik der Medizinischen Fakultät in Plzen): Meteorotropismus plötzlicher Herz- und Gefässerkrankungen.

KWASNIEWSKA-BASZCYK, M. (Institut balneoklimaticzny, Poznan): Groer-Hecht's Reaktion bei Kindern während einer Sanatoriumskur an der Ostseeküste.

NOVÁK, J. (I.Dermatologische Klinik der Medizinischen Fakultät in Praha): Periodizität der Entstehung und des Verlaufs einiger Krankheiten.

SVORAD, D. and WELLNEROVÁ, J.(Physiologisches Institut der ČSAW, Praha): Einfluss einiger meteorologischer Faktoren auf den Rhytmus des Schlafes und des Wachens mit besonderer Berücksichtigung der Schlaflosigkeit bei Tieren.

CUPCEA, S. and DELEANU, M. (Institut do igiena, Cluj): Experimentelle und klinische Forschungen über einige Einflüsse der Luftionen auf den Organismus.

NOVÁK, J. (1.Dermatologische Klinik der Medizinischen Fakultät in Praha): Einfluss der Veränderungen des Geomagnetismus auf die Entstehung und den Verlauf einiger Krankheiten.

TICHÝ, S. (Klinisches otorhinolaryngologisches Laboratorium der ČSAW, Praha): Einfluss der äusseren Umwelt auf das Krankenhaus-Mikroklima.

BERJUSCHEW, K.G. (Institut für die Vervollkommung von Aerzten, Moskau): Einfluss der Grünanlagen auf die Verbesserung der mikroklimatischen und hygienischen Bedingungen in den Siedlungen nach den Angaben der Forschungsarbeiten sowjetischer Hygieniker (Russisch)

KAZDOVÁ, PhMr (Hygienisch-epidemiologische Bezirksdienststelle) and HAVLÍČEK, V. (Landwirtschaftliche Hochschule in Brno): Einfluss industrieller Exhalationen und meteorologischer Elemente auf die örtliche Verteilung des Steubfalles in Siedlungen.

BÖHM, B. (Hydrometeorologische Anstalt, Praha): Antrag zur Vereinheitlichung der Methodik der katathermometrischen Messung.

CHOBOT, H. and JEZOWA, L. (Instytut balneoklimatyczny, Poznań): Verhalten der Nasen-Rachen Flora bei Kindern nach einer Ostseebadkur.

CERMÁK, K. (Forschungsanstalt für Forstwirtschaft, Zbraslav-Stiřady): Einfluss der Witterung auf die Unfallshäufigkeit in der forstlichen Produktion.

LIMAN, S. (Instytut balneoklimaticzny, Poznań): Mikroklimatische Untersuchungen in den Stollen und Kammern des Salzbergwerks von Inowroclaw.

VESELÝ, E. (Forschungsinstitut für Balneologie, Praha): Erwärmung im Wasser.

WELLNEROVÁ, J. and SVORAD, D. (Physiologische Anstalt der ČSAW): Interindividuelle Veränderungen des emotionellen Verhaltens durch den Einfluss der Temperatur und Luftfeuchtigkeit.

LIMAN, S. (Instytut balneoklimatyczny, Poznań): Ueber den Stand polnischer Forschungsarbeiten auf dem Gebiete der Bioklimatologie des Menschen.

CUPCEA, S. and DELEANU, M. (Institutul de igiena, Cluj): Einige Probleme der geographischen Verteilung der Luftionisation in der Rumänischen Volksrepublik.

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* Information concerning reports etc. can be obtained from Ing. V. Krečmer: Ceskoslovenska Akad. ved, 34 Zborovská, Praha 16, Czechoslovakia.

PICHA, J. (Hydrometeorologischen Institut, Observatorium Neuköniggrätz (Nový Hradec Králové)) : Erfahrungen bei der Messung des bodennahen Ozons.

STRUŽKA, Vl. (Anstalt für Hygiene, Praha): Methoden von Geländeuntersuchungen in bioklimatischer Richtung.

MADE, A. (Forschungsinstitut für Agrarmeteorologie, Halle/Saale): Bericht über einige Erfahrungen auf dem Gebiete der meteorologischen Geländevermessung.

KLEČKA, M. and STRÁDAL, V. (Forschungsinstitut für Agrarökonomik der ČSAL in Praha): Praktische Ausnützung der landwirtschaftlichen Bioklimatologie bei der Produktionsplanung in der Tschechoslowakei.

HLAVÁČ, V. (Institut für Gebietsplanung, Praha): Beitrag zur Methodik der Standortverteilung der landwirtschaftlichen Produktion vom bioklimatologischen Gesichtspunkt (am Beispiel des Bezirkes Ceské Budějovice).

HESSE, W. (Institut für Agrarmeteorologie d. Karl-Marx-Universität, Leipzig): Ueber die Methodik der Bestandesklimamessungen.

BALCAR, J. (Forschungsinstitut für Tabakindustrie, Báb): Einfluss des Klimas und des Bodens auf die Tabakpflanze in der Vietnamesischen demokratischen Republik.

BERÉNYJ, D. (Universität Debrecen): Ueber das Bestandesklima des Maises.

KURPELOVÁ, M. (Hydrometeorologisches Institut, Bratislava): Beitrag zum Wachstum und zur Entwicklung einiger Fruchtarten im Zusammenhang mit der Witterung.

ŠKULA, K. (Forschungsinstitut für Tabakindustrie, Báb): Einfluss der Witterung auf die Dauer der Wachstumsphasen beim Tabak.

PEJML, K. (Hydrometeorologisches Institut Observatorium Doksany a/E): Beitrag zum Bestandesklima der Kartoffeln vom Gesichtspunkt der Entstehung der Kartoffelfäule.

BERÉNYJ, D. (Universität Debrecen): Ueber die in Weinkellern und Höhlen angewandten Beobachtungsmethoden.

MAJERNÍK, O. (Biologisches Institut der SAW, Bratislava): Wirkung klimatischer Faktoren auf einige phytogene Organismen im Zusammenhang mit ihrer Schädlichkeit für die Weinrebe und Aprikose.

FOLTÝN, O. (Laboratorium für Pflanzenschutz der SAW, Ivanka pri Dunaji): Klimatische Einflüsse auf die Entstehung und Entwicklung der Perenospora der Weinrebe.

KREČMER, V. and IZERA, V. (Forschungsanstalt für Forstwirtschaft, Zbraslav-Strnady): Neuer Typ eines Apparates zum Messen des täglichen Sonnenbogens.

KEŠNER, B. (Laboratorium für Agrometeorologie der ČSAL, Praha): Neue Methode der Ermittlung der erforderlichen Lüftungsintensität abgeschlossener Räume nach der CO_2 - Konzentration.

SLAVÍK, B. (Biologisches Institut der ČSAW, Praha): Requivalente Verdunstung, ihr Höhengradient und seine ökologische Bedeutung.

VELIKOVSKÝ, V. (Forschungsinstitut für Getreide, Kroměříž) and KRHOUNEK, V. (Hydrometeorologisches Institut, Praha): Ergebnisse der Messung in Winterroggenbeständen bei der Ermittlung der zwischen einigen klimatischen Faktoren und der Entwicklung des Schneeschimmels bestehenden Beziehung.

TREFNÁ, E. (Hydrometeorologisches Institut, Praha) and MAREČEK, F. (Forschungsinstitut für pflanzliche Produktion, Praha): Einige aus Beobachtungen des Mikroklimas im ungeheizten Gewächshaus gezogene Schlüsse.

HAVLÍČEK, V. (Hochschule für Landwirtschaft, Brno): Mesoklimatische Besonderheiten von Stauseen und Wasserflächen in ihrem täglichem Gang.

SLAVÍK, B. and CATSKÝ, J. (Biologisches Institut der ČSAW, Praha): Methode der Ermittlung der CO_2 - Konzentration in der Luft.

PASÁK, V.(Forschungsinstitut für Meliorationen der ČSAL, Praha): Mikroklimatische Verhältnisse bei der Aufforstung von Sandböden.

TOMANEK, J. (Szkola glowna gospodarstva wiejskiego, Warszawa): Gestaltung der mikroklimatischen Verhältnisse in verschiedenen Lochschlagbetriebstypen.

VOLNÁ, M. (Forstliche Hochschule, Brno): Beurteilung von Nestpflanzung und -Saat vom Gesichtspunkt ihrer mikroklimatischen Wirkung.

VOLNÝ, S. (Forstliche Hochschule, Brno): Einfluss des gemeinen Wacholders auf einige mikroklimatische Prozesse der erdnahen Luftschichten und der oberen Bodenhorizonte als Voraussetzung einer bedeckenden Komponente bei der bodenschützenden Aufforstung.

INTRIBUS, R. (Forstliches Laboratorium der SAW, Zvolen): Beitrag zum Mikroklima von Oedland in der Slowakei.

BAUMGARTNER, A. (Meteorologisches Institut der forstlichen Forschungsanstalt, München): Die klimatischen Standortsfaktoren an einem Berg des Böhmerwaldes.

KRECMER, V. (Forschungsinstitut für Forstwirtschaft. Zbraslav-Strnady): Grösse der Hiebkessel in Kieferbeständen in Niederungslagen vom Gesichtspunkt der Mikroklimatologie

KORTÜM, F. (Forstliche Hochschule, Eberswalde): Die Verdunstung von Waldböden und Freilandflächen.

ZACHAR, D. (Forstliches Laboratorium der SAW, Zvolen): Einfluss des Reliefs auf den Wasserhaushalt des Bodens.

VINŠ, B. (Forschungsinstitut für Forstwirtschaft, Zbraslav- Strnady): Witterung und forstlicher Holzartenzuwachs.

KŘIVSKÝ, V. (Astronomisches Institut der ČSAW, Ondřejov): Säkulärer Trend von Witterung und Zuwachs.

CHALUPA, V. (Forschungsinstitut für Forstwirtschaft, Zbraslav-Strnady): Neue Methoden der forstlichen laubholzbestand Phänologie.

SLAVÍK, B. (Biologisches Institut des ČSAW, Praha): Das Eindringen des Regenwassers in den Laubholzbestand.

KVĚT, J. (Geobotanisches Laboratorium der ČSAW, Průhonice): Bisherige Erfahrungen mit der Integrationsmethode der Messung von Bodentemperaturen mittels der Sacharoseinversion.

KREČMER, V.and FOJT,W. (Forschungsanstalt für Forstwirtschaft, Zbraslav-Strnady):Niederschlagsmesser für mikroklimatologische und ökologische Studien.

HOLOVSKÝ, M. (Institut für Wald- und Jagdwesen der ČSAL, Praha): Funktionall ökonomische Grünanlagen in der Industrie.

HOLOVSKÝ, M. (Institut für Wald- und Jagdwesen der ČSAL, Praha): Dynamische Modifikation der Waldschutzgürtel in der Industrie.

MATĚJKA, V. and CHROUST, M. (Forstliche Fakultät, ČVUT, Technische Hochschule, Praha): Mikroklimatische Forschungsarbeit auf dem Gebiete von Trockenkammern grundlegenden Typen in den Grosskleinganstalten.

M I S C E L L A N E O U S   B I O C L I M A T O L O G I C A L   D A T A
Section B: Reports of Congresses of national bioclimatological societies

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PROGRAM BIOCLIMATOLOGICAL CONFERENCE ON CLIMATOLOGICAL AND BALNEOLOGICAL HEALTH RESORTS AT E.BERLIN, D.D.R. (3-5 MARCH 1959) *

KURORTKLIMA

W. BOËR (Potsdam)	: Zum Begriff des Lokalklimas
H. ZENKER (Bad Berka)	: Die Bedeutung des Lokalklimas von Kuranlagen - am Beispiel einer Tuberkulose-Heilstätte
W. WÒJTOWICZ (Posen)	: Die Auswertung der klassischen Klimadaten in der Kurortklimatologie - am Beispiel des Berglandes von Kłodzko
W. UNDT (Wien)	: Bioklimatische Arbeitsmethoden
G. HENTSCHEL (Berlin)	: Bioklimatische Arbeitsmethoden
L. TRAUNER (Zagreb)	: Klimakurort - Kurortklima
H. PFLEIDERER	: Bedeutung und Technik der Frigorigraphie
H. GRIMM (Berlin)	: Das Strandleben an der Ostseeküste in Abhängigkeit von Wärmestrahlung und Abkühlungsgrösse
H.P. MOCHMANN (Rostock)	: Leptospirosen, ein Beitrag zur Lokalbioklimatologie
A.v. KNORRE (Oschersleben)	: Ueber Asthmafragen
G. HENTSCHEL (Berlin)	: Untersuchungsergebnisse der Sterblichkeit unter verschiedenen lokalen Gegebenheiten
I. KÉRDÖ (Budapest)	: Komplexe Betrachtungsweise bei der Beurteilung von biologischen Wirkungen klimatischer Umweltfaktoren
K. MENYHÉRT (Budapest)	: Biometeorologischer Dienst und Forschung in Ungarn
H. MROSE (Dresden)	: Untersuchungsergebnisse über reduzierende Spurenstoffe in der Atmosphäre
U. JESSEL (Westerland/Sylt)	: Stickoxyde als Ursache von Fehlern in der chemischen Ozonometrie ?
F. PFEIFER (Leipzig)	: Die festen Schwebstoffe in der Atmosphäre und ihre natürliche Radioaktivität
R. NOACK (Berlin)	: Die lufthygienische Situation in einigen Kurorten und Erholungszentren der DDR sowie Hinweise für Neuanlagen von Kurzentren
L. RASSOW (Halle)	: Zum Problemkreis Lufthygiene
J. KOLBIG (Potsdam)	: Abschätzung der Ausbreitung von Luftverunreinigungen
K. SEIFERT (Berlin)	: Staatliche Massnahmen zum Schutze des Klimas in Kurorten
F.E. CARL (Berlin)	: Bioklimatologie und Erholungsplanung

KLIMATHERAPIE

A. KUKOWKA (Greiz)	: Zum Problem der Luftelektrizität
PICHOTKA (Berlin)	: Die Abhängigkeit der Sauerstoffaufnahme von der Sauerstoffspannung, insbezondere bei geringen Erniedrigungen des Sauer-

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* Information concerning reports etc. can be obtained from Dr. Ortmeyer: Forschungsinstitut für Bioklimatologie, Hufeland-Krankenhaus, Haus 1, Karowerstrasse 11, Berlin-Buch, DDR.

	stoffpartialdrucks
K. LÜHR (Dresden)	: Objektivierung des Kurerfolges bzw. Kureffektes
E.G. SCHULTZE (Wyk auf Föhr)	: Ueber die Objektivierung der Kurergebnisse an der See
SCHIRGEL (Heiligendamm)	: Objektivierung des Gesamtkureffektes im Seeheilbad mit dem Leistungsprüfgerät nach Prof. Böhlau
SCHIRGEL (Heiligendamm)	: Akklimatisationsstudien im Seeheilbad Heiligendamm
H. WAGNER (Bad Elster)	: Die Beeinflussung des Organismus im Kurort - nachgewiesen am Verlauf der kollektiven Körpertemperatur
M. KALINOWSKI (Posen)	: Einfluss der Kurortbehandlung auf die Erhaltung der Leistungsfähigkeit alternder Menschen.
E.v. PHILIPSBORN (Oberstdorf)	: Indikationen für eine Klimakur im Gebirge
I. ILIJEW (Sofia)	: Physiologische Bemerkungen zur Methodik des Sporttrainings im Gebirge während der Akklimatisation
K. LINSER (Berlin)	: Die Klimatherapie bei Hautkrankheiten
F. FUCHS (Karl-Marx-Stadt)	: Klimatherapeutische Möglichkeiten für konstitutionelle Neurodermatiker auf dem Fichtelberg
K. HARNACK (Berlin)	: Auswertung unserer klimatischen Heilkuren bei Hautkranken

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Section B: Reports of Congresses of national bioclimatological societies

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"PROBLEME DER BIOKLIMATOLOGIE UND DES STALLKLIMAS BEI DER RINDER- UND SCHWEINEHALTUNG"

(Program of Symposium to be held at Pössneck, Thüringen, D.D.R., on 28 and 29 May 1959)*

PROBLEME DER BIOKLIMATOLOGIE

Uebersichtsreferat

Die Bioklimatologie als Hilfsmittel der modernen Haltungsforschung (Methoden und Geräte, Ziele).

Die Konstitutionsforschung und die Bioklimatologie.

Die Veterinärhygiene und die Bioklimatologie in der Haustierhaltung.

Das Strahlungsklima und sein Einfluss auf die landwirtschaftlichen Nutztiere.

Probleme der Tierhaltung auf bioklimatischer Grundlage unter den Bedingungen des Kontinentalklimas.

Offene Fragen des Tierzüchters an die Haltung und die Bioklimatologie der Tiere unter mitteleuropäischen Verhältnissen.

ERGEBNISSE DER HALTUNGSFORSCHUNG BEI RINDERN UND SCHWEINEN

In der Tschechoslovakei

In Ungarn

In Dänemark

In Belgien

In der Bundesrepublik Deutschland

In der Deutschen Demokratischen Republik

STALLKLIMA UND STALLHYGIENE

Die physiologischen Grundlagen für die Berechnung des Stallklimas.

Wärmewirtschaftliche Unterlagen für die Berechnung des Stallklimas.

Welche Darstellungsform des Stallklimas ist notwendig ?

Ueber eine neue Berechnungsgrundlage des Stallklimas.

Welche Lüftungssysteme sind im Stallbau anzuwenden ?

Fragen der Baustoffprüfung.

Ergebnisse von Baustoffprüfungen in Schweden.

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* Information concerning the Symposium can be obtained from Dr. Scholz, Forschungsstelle für Tierhaltung Knau, Knau (über Triptis i. Thür., Kreis Pöszneck).

Section C : Bioclimatological stations and institutions

I.J.B.B. Vol. III, 1959, part VII, section C

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section C: Bioclimatological stations and institutions

DIE BIOKLIMATOLOGIE DES MENSCHEN IN POLEN

von

Mgr. St. Liman (Poland)*

I. DIE POLNISCHE BIOKLIMATOLOGIE DES MENSCHEN IN DER ZWISCHENKRIEGSZEIT

Auch in Polen sind seit einigen Jahren Probleme der Bioklimatologie des Menschen zum Gegenstand eingehender Forschungen geworden. Sie erregten das Interesse unserer Meteorologen, Klimatologen und Aerzte - und ganz besonders der Kurärzte. Es ist daher kein Zufall, wenn wir unter den Pionieren der polnischen Bioklimatologie nicht nur Namen von Geophysikern, sondern auch von Aerzten finden. Von den Bahnbrechern der gegenwärtigen Bioklimatologie des Menschen, deren wesentliche Entwicklung in die dreissiger Jahre unseres Jahrhunderts fiel, sind folgende Aerzte zu nennen: L. Korczyński, A. Sabatowski und M. Michałowicz. Ihren wissenschaftlichen Arbeiten auf dem Gebiete der medizinischen Bioklimatologie ist es zu verdanken, dasz für diese Probleme ausser den Aerzten auch die Naturwissenschaftler gewonnen wurden. Unter den Meteorologen dagegen gebührt die gröszte Anerkennung W. Gorczyński und E. Stenz. Ihre Forschungsarbeiten auf dem Gebiete der Aktinometrie führten zu einer genaueren Kenntnis des Solarklimas nicht nur Polens, sondern auch anderer Länder. Ein weiteres Verdienst von Stenz ist die Errichtung der ersten biometeorologischen Forschungsstation, die auf dem Kasprowy Wierch (polnische Hohe Tatra) im Jahre 1938 ihre Arbeit begann. Es wurden dort folgende Elemente des Bioklimas untersucht:

1. die Sonnenstrahlung unter Berücksichtigung des Sonnenspektrums im sichtbaren Lichte, Infrarot und Ultraviolett;
2. die atmosphärische Luftelektrizität (mit Israels Meszgerät);
3. die biologische Abkühlungsgrösze (mit dem Frigorimeter nach Thilenius-Dorno).

Das Arbeitsprogramm dieser Station berücksichtigte auch meteoro-physiologische Probleme, die der Hochgebirgs-Klimatherapie dienten. Die ersten Ergebnisse der vielversprechenden Forschungsarbeiten auf dem Kasprowy Wierch wurden leider durch den Ausbruch des zweiten Weltkrieges nebst seinen Folgen vernichtet.

Bei einer Bewertung des Standes der polnischen Forschung auf dem Gebiete der Bioklimatologie des Menschen in der Zwischenkriegszeit musz man feststellen, dasz wir zwar im Vergleich mit den westlichen Ländern im Rückstand waren, jedoch diesen Wissenszweig entsprechend den damals gegebenen technischen und finanziellen Möglichkeiten entwickelten. Die polnische Bioklimatologie dieser Zeit kann zwar keine gröszere Anzahl von wissenschaftlich-experimentellen Arbeiten aufweisen - erstens hauptsächlich deshalb, weil die Unterstützung gut eingerichteter Forschungsstellen fehlte - und zweitens, weil die Probleme, mit denen sich die bestehenden Arbeitskreise beschäftigten, durch eine gewisse Zufälligkeit bestimmt waren. Als eine bedeutende Errungenschaft dürfen jedoch zahlreiche Beiträge und populär-anschauliche Arbeiten angesehen werden. Auch die Herausgabe des von Korczynski verfassten zweibändigen 872 Seiten umfassenden Lehrbuches der medizinischen Klimatologie (heute schon teilweise veraltet) ist ohne Zweifel eine namhafte Errungenschaft der polnischen Bioklimatologie der Zwischenkriegszeit.

* Aus dem Forschungs-Institut für Balneologie und Klimatologie in Poznań (Poland); Direktor: Dr. J. Jankowiak.

II. DIE ENTWICKLUNG DER BIOKLIMATOLOGIE DES MENSCHEN IN DER NACHKRIEGSZEIT

A. ORGANISATION.

Der letzte Weltkrieg bedeutete eine Zwangspause in den Arbeiten unserer Bioklimatologen und verursachte einen groszen Verlust von den ohnehin nicht zahlreichen Fachleuten, Meteorologen, Klimatologen und Aerzten, die alle an der Entwicklung der Bioklimatologie des Menschen gearbeitet hatten. Daher bemühten sich unsere Wissenschaftler in den ersten Nachkriegsjahren vor allem um die Ausbildung eines jungen Nachwuchses. Im Vergleich mit der Vorkriegszeit ist das Interesse an bioklimatologischen Problemen nach dem Jahre 1945 in Volkspolen bemerkenswert gestiegen. Ohne Zweifel hängt dies mit dem intensiv fortschreitenden Umbau der wirtschaftlichen Struktur unseres Landes zusammen, den wiederum die Entwicklung unserer Industrie und speziell. der grundlegenden Rohstoffbasis des Bergbaus und der Hüttenindustrie bewirkt hat. Aus diesem Grunde wurden vorzugsweise auf weite Sicht Pläne einer Raumbewirtschaftung von Städten und Siedlungen in Arbeit genommen. Da diese hauptsächlich auf einer Analyse der lokalen klimatischen Verhältnisse und der Lufthygiene basierten, erforderten sie die Zusammenarbeit mit Klimatologen. Gleichzeitig mit der fortschreitenden Industrialisierung machte sich eine Zunahme von Berufskrankheiten bemerkbar ; dies verursachte zweifellos ein regeres Interesse an den Problemen der Sanitätshygiene und der medizinischen Bioklimatologie und trug zur Entwicklung der letzteren bei.

Von den augenblicklich auf dem Gebiete der medizinischen Bioklimatologie tätigen Arbeitskreisen kann man erwähnen:

1. die mikroklimatologische Forschungsstelle der Abteilung für Stadthygiene am Staatlichen Hygiene-Institut in Warszawa, die sich hauptsächlich mit sanitäts-hygienischen Problemen der Städte befasst;
2. die bioklimatologische Abteilung am Institut für Balneologie und Klimatologie in Poznań, die seit dem Jahre 1952 besteht und Probleme der medizinischen Bioklimatologie - vor allem der Kurortbioklimatologie - bearbeitet. Beide Stellen sind dem Gesundheitsministerium untergeordnet.
3. Als dritte Forschungsstelle ist die biometeorologische Abteilung am Staatlichen Hydro-Meteorologischen Institut in Warszawa zu verzeichnen. Ihr Forschungsprogramm umfasst ausgewählte Probleme der Meteorologie und der medizinischen Klimatologie.

Auszer den besprochenen drei Arbeitskreisen werden von einigen Lehrstühlen für Hygiene an den Medizinischen Akademien bzw. meteorologischen und klimatologischen Instituten der Universitäten neben dem allgemeinen Forschungsplan gewisse Probleme der medizinischen Bioklimatologie bearbeitet.

B. DIE INSTRUMENTELLE AUSSTATTUNG DER FORSCHUNGSSTELLEN.

Die in biometeorologischer Hinsicht am besten eingerichteten Beobachtungsstellen besitzt das Staatliche Hydro-Meteorologische Institut. Die biometeorologische Abteilung des obengenannten Instituts hat sowohl ein Aussenbeobachtungsnetz wie auch eine Zentralstation in Warszawa. Es werden dort vor allem das Solarklima (Sonnenstrahlung, Sonnenscheindauer), die Luftabkühlungsgrösze, sowie das Bioklima der Städte und der Industriezentren erforscht. Es ist auch bemerkenswert, dasz der obengenannten Forschungsstelle des gesamte meteorologische Archivmaterial jederzeit zugänglich ist.

Das Institut für Balneologie und Klimatologie verfügt bisher über keine ständige biometeorologische Beobachtungsstelle. Das Institut ist jedoch im Begriff neue biometeorologische Forschungsstellen in Kurorten verschiedener physiographischer Regionen unseres Landes zu errichten. Für die Gebirgslandschaft sollten diese in Krynica bzw. Szczawnica und in Zakopane (Hohe Tatra) entstehen; für die mittelpolnische Tiefebene im Kurort Inowrocław und für die Küstenlandschaft im Ostseebad Kołobrzeg. Diese Beobachtungsstellen, die mit klima-physiologischen Laboratorien ausgestattet werden müssen, würden als Forschungsstellen für das Kurortklima jener Gegenden dem Institut für Balneologie und Klimatologie untergeordnet sein. Bis dahin ist das Institut gezwungen, in eigenen Forschungsarbeiten an ausgewählten Elementen des Kurortklimas sich vorwiegend auf stichprobenartige Geländebeobachtungen zu stützen. Augenblicklich werden seitens des Instituts für Balneologie und Klimatologie dauernde Messungen der Intensität der Sonnenstrahlung in Inowrocław, sowie Messungen der Sonnenscheindauer und Abkühlungsgrösze der Luft in zwei Kurorten Inowrocław und Rymanów-Zdrój, durchgeführt.

Von einer Gesamtzahl von 28 Kurorten, die der zentralen Kurortverwaltung unterstellt sind, besitzen 23 Kurorte meteorologische Stationen. Davon bestehen meteorologische Stationen I. Ordnung in 2 Kurorten, II. Ordnung in 6 und III. Ordnung in 15 Kurorten. Alle diese Beobachtungsstellen unterstehen dem Staatlichen Hydro-Meteorologischen Institut.

III. DIE FORSCHUNGSRICHTUNG UND ANGEWANDTE ARBEITSMETHODEN AUF DEM GEBIETE DER BIOKLIMATOLOGIE DES MENSCHEN

Die Forschungsarbeiten auf dem Gebiete der Bioklimatologie des Menschen gehen in zwei Richtungen: A. der biologischen, B. der physikalischen.

A. DIE BIOLOGISCHE RICHTUNG.

Aenlich wie in anderen Ländern, gehen auch unsere meteoro-klimabiologischen Forschungen in Richtung einer Korrelation der biologischen Prozesse des menschlichen Organismus mit den Wetterprozessen. Als Gegenstand speziellen Interesses sind meteoro-pathologische Probleme, alsdann der Jahreszeitrhythmus gewisser Krankheiten (z.B. Kreislaufstörungen, Krankheiten der Luftwege, Bewegungsstörungen und andere) zu verzeichnen. In dieser Richtung gehen eben auch die Arbeiten der bioklimatologischen Abteilung des Instituts für Balneologie und Klimatologie, sowie der biometeorologischen Abteilung des Staatlichen Hydro-Meteorologischen Institut.

Die klima-biologischen, bzw. meteoro-biologischen Arbeiten werden bei uns mit den allgemein bekannten und angewandten Methoden durchgeführt; nämlich mit Hilfe der statistischen, experimentellen und dynamischen Methode.

Zur Vervollständigung eines allgemeinen Bildes der Thematik der durchgeführten Forschungen kann man beispielsweise einige der bearbeiteten Probleme anführen. So befasste man sich in den letzten Jahren mit dem Problem der Wärmeregulation des kindlichen Organismus in Beziehung zu balneoklimatischen Reizen, weiter mit biologischen und pharmako-dynamischen Reaktionen, ebenfalls bei Kindern, bei denen die thalasso-therapeutische Heilmethode angewandt wurde.

Andere Arbeiten auf dem Gebiete der Meteoropathologie befassten sich mit Problemen, wie z.B. dem Einflusz des Wetters auf rheumatische Schmerzzustände, auf Erkrankungen überhaupt, und auf die Letalität.

KLIMATHERAPIE

In der klima-biologischen Problematik musz auch die Klimatherapie berücksichtigt werden. Dieses Problem ist bei uns fast ausschliesslich das Wirkungsgebiet des Instituts für Balneologie und Klimatologie. Die gröszte Aufmerksamkeit schenkt man augenblicklich den Erfolgen der Klimaheilkuren bei allergischen Krankheiten des Kinderalters, aber auch bei Erwachsenen im See- und Gebirgsklima und letztens auch der klimatherapeutischen Behandlung in den Kammern des Salzbergwerkes in Wieliczka (hier unter wissenschaftlicher Aufsicht von Sabatowski und Obtułowicz).

B. DIE PHYSIKALISCHE RICHTUNG IN DER MEDIZINISCHEN BIOKLIMATOLOGIE.

Man befasst sich hier mit der Erforschung der einzelnen Elementen des Bioklimas: z.B. der Abkühlungsgrösze der Luft, der Sonnenstrahlung mit Berücksichtigung der U.V.-Strahlung, der Luftverunreinigung, der atmosphärischen Luftelektrizität, sowie dem Ozongehalt in der Grundschicht der Luft usw.

DIE ABKUEHLUNGSGROESZE

Das Problem der Abkühlungsgrösze der Luft ist Forschungsgegenstand mehrerer Anstalten. Besonders grosze Erfolge auf dem Gebiete der Abkühlungsforschung kann die biometeorologische Abteilung des Staatlichen Hydro-Meteorologischen Instituts aufweisen, die schon seit einigen Jahren systematisch katathermometrische Messungen an 31 Punkten der gesamten Landesfläche durchführt. In dieser Forschungsstelle hat man nicht nur für einzelne Orte (wie z.B. Ciechocinek oder Zakopane) das Material bezüglich der Luftabkühlungsgrösze bearbeitet, sondern auch für ganze Landesteile, z.B. für die südliche Ostseeküste, wobei man die Ergebnisse aus verschiedenen Orten des betreffenden Gebietes als Grundlage genommen hat.

DIE SONNENSTRAHLUNG

In der Erforschung des Solarklimas ist in Polen im Laufe der letzten Jahre ein groszer Fortschritt im Vergleich zur Vorkriegszeit zu verzeichnen. Das gegenwärtig bestehende aktinologische Netz umfasst 14 ständige Beobachtungsstellen, wovon 11 auf aktinographische und 3 auf aktinometrische Beobachtungsstellen entfallen. Das heliographische Netz dagegen stützt sich auf Beobachtungen, die in 60 Ortschaften registriert werden. Die Mehrzahl der obengenannten Beobachtungsstellen ist dem Staatlichen Hydro-Meteorologischen Institut untergeordnet.

Die Forschungsarbeiten über das Solarklima (Intensität der Sonnenstrahlung, Sonnenscheindauer) führen bei uns hauptsächlich: die biometeorologische Abteilung am Staatlichen Hydro-Meteorologischen Institut in Warszawa, dann die Beobachtungsstelle der Abteilung für Geophysik an der Polnischen Akademie der Wissenschaften in Belsk (bei Warszawa), die bioklimatische Forschungsstelle des Instituts für Zoologie an der Polnischen Akademie der Wissenschaften in Białowieża,

das Observatorium des Instituts für Meteorologie und Klimatologie der Universität zu Wrocław, sowie das Institut für Balneologie und Klimatologie in Poznań, welches über Beobachtungsstellen in den Kurorten Inowrocław und Rymanów-Zdrój verfügt.

Auszerdem bestehen einige andere Forschungsstellen, wie z.B. die klimatologische Abteilung des Geographischen Instituts der Polnischen Akademie der Wissenschaften (Warszawa), dann die Lehrstühle für Meteorologie und Klimatologie der Universitäten in Toruń, Lublin und Wrocław, die sich mit periodischen aktinometrischen Messungen der direkten Sonnenstrahlung befassen zwecks Bestimmung des Energieverlustes, der durch Verunreinigung der Atmosphäre der Städte verursacht wird. Dasselbe Problem erforschen im oberschlesischen Industriegebiet die obenerwähnte klimatologische Abteilung des Geographischen Instituts der Polnischen Akademie der Wissenschaften gemeinsam mit dem Institut für Meteorologie und Klimatologie der Universität in Wrocław. Die Ergebnisse dieser Forschungen sind bereits in einem speziellen Bericht (Biulletin) veröffentlicht worden, der vom Kommittee für die Angelegenheiten des oberschlesischen Industriegebietes an der Polnischen Akademie der Wissenschaften herausgegeben wurde. Diese Forschungsergebnisse wurden auszerdem im "International Journal of Bioclimatology and Biometeorology", vol I, 1957, part I, section D: "Rapporte des I. Internationalen Kongresses für Bioklimatologie und Biometeorologie - Wien, 23 - 27 IX. 1957", veröffentlicht.

Gegenwärtig führt die Mikroklimatische Abteilung der Sanitär-Epidemiologischen Station in Katowice in Oberschlesien profilartige Beobachtungen der Sonnenstrahlung durch.

Von anderen Arbeiten auf dem Gebiete der Sonnenstrahlung sind die studienartigen Arbeiten, die in der mikroklimatischen Forschungsstelle der Abteilung für Stadthygiene am Staatlichen Institut für Hygiene (Warszawa) und in der bioklimatischen Forschungsstelle des Instituts für Zoologie an der Polnischen Akademie der Wissenschaften in Białowieża geführt werden, zu nennen. Sie erforschen u.a. die Meszmethoden der biologisch aktiven Ultraviolettstrahlung.

STAUBGEHALT DER LUFT

Das Verstaubungsproblem groszer Stadtzentren, vor allem gewisser Industriebezirke - wie des oberschlesischen Industriegebietes oder des Steinkohlenreviers von Wałbrzych (Niederschlesien)- war in den letzten Jahren Forschungsgegenstand unserer Bioklimatologen. In Oberschlesien führte das speziell für die Klimaangelegenheiten des oberschlesischen Industriegebietes berufene Kommittee an der Polnischen Akademie der Wissenschaften in einer Zusammenarbeit mit dem Institut für Meteorologie und Klimatologie der Universität zu Wrocław sowie dem Staatsunternehmen "Energopomiar" (Gliwice) längere Messungsserien des Staubgehalts der Luft durch. Bei diesen Untersuchungen bediente man sich zweier Methoden:

1. der Sedimentationsmethode,
2. der konimetrischen Methode (Staubmesser von Ovens).

Die Forschungsergebnisse wurden in dem schon vorher erwähnten Bericht (Biulletin) des Kommittees für die Angelegenheiten des oberschlesischen Industriegebietes an der Polnischen Akademie der Wissenschaften veröffentlicht.

Auch in anderen Städten wurde der Staubgehalt der Luft untersucht. So z.B. führte in Gdynia und Zakopane das Staatliche Hydro-Meteorologische Institut Messungen aus, in Kraków die Polnische Meteorologisch-Hydrologische Gesellschaft, in Warszawa die Sanitäts-Epidemiologische Station, in Wałbrzych das Physiographische Staatsunternehmen "Geoprojekt" und in Lublin, Łódź und Wrocław die sich an dortigen Universitäten befindlichen Institute für Klimatologie und Meteorologie.

Die in Wrocław durchgeführten Messungen führten zu folgenden Ergebnissen:

a. Der Staubgehalt der Luft in dieser Stadt ist in kühlen Jahreszeiten (Heizperiode) fast vierfach gröszer als in den warmen Jahreszeiten.
b. Es wurde eine Korrelation zwischen dem Staubgehalt und einigen meteorologischen Elementen bestimmt.

Auszerdem erwiesen die gleichzeitig durchgeführten aktinometrischen Beobachtungen, dasz das von der Stadt erzeugte Aerosol anders die Strahlung der Sonne und des Himmels beeinfluszt, als das Aerosol der freien Atmosphäre.

DIE ATMOSPHAERISCHE LUFTELEKTRIZITAET

Die Probleme der atmosphärischen Luftelektrizität stellen in Polen gegenwärtig einen Aufgabenkreis zweier Forschungsstellen dar:

a. des Geophysikalischen Observatoriums der Polnischen Akademie der Wissenschaften in Świder bei Warszawa,
b. des Meteorologischen Instituts an der Agrarhochschule zu Poznań.

DIE RADIOAKTIVITAET DER LUFT UND DER NIEDERSCHLAEGE

Diese Fragen werden in Polen an folgenden Forschungsstellen bearbeitet:

1. In der aerologischen Abteilung des Staatlichen Hydro-Meteorologischen Instituts in Legionowo bei Warszawa und in einigen Auszenkontrollmeszstellen, die der obengenannten Zentralstelle untergeordnet sind.
2. Am Lehrstuhl für allegemeine Physik an der Bergakademie in Kraków, der das Problem der Radioaktivität der Luft unter zwei Gesichtspunkten betrachtet und zwar:
   (a) den Einflusz der klimatischen Verhältnisse auf die Radioaktivität der Luft,
   (b) die radioaktiven Verunreinigungen als Konsequenz der nuklearen Explosionen.
3. In der chemischen Abteilung des Instituts für Balneologie und Klimatologie in Poznań. Man befässt sich hier mit dem Problem der Radioaktivität der Niederschläge.

OZON

An der Meszmethodik des bodennahen Ozons und der Konstruktion einer geeigneten Meszapparatur arbeiten:

1. die mikroklimatische Forschungsstelle der Abteilung für Stadthygiene am Staatlichen Institut für Hygiene (Warszawa),
2. die klimatische Abteilung des Geographischen Instituts der Polnischen Akademie der Wissenschaften (Warszawa), die schon einige Meszserien von Ozonkonzentration in der Grundschicht der Luft im Kurort Ciechocinek durchgeführt hat.

IV. DIE KLIMATOGRAPHIE DER KURORTE IN BIODYNAMISCHER HINSICHT

Gegenwärtig ist dieser Teil der Kurortklimatologie bei uns am meisten entwickelt. Man arbeitet jetzt an verschiedenen Forschungsstellen an einer Reihe von klimatologischen Monographien der Kur- und Erholungsorte bzw. Regionen, wozu man hauptsächlich das langjährige makroklimatische Material verwertet hat. So z.B. hat bereits die bioklimatische Abteilung des Instituts für Balneologie and Klimatologie eine umfangreiche Klimamonographie für den Talkessel und das Bergland von Kłodzko und eine weitere für das Schlesische Beskidenbergland fertiggestellt. In Bearbeitung befindet sich auch eine monographische Erfassung des Makroklimas der Westsudeten. Es sind auszerdem auch Klimacharakteristiken einzelner Kurorte z.B. von Ladek-Zdrój (Sudeten), Rymanów-Zdrój (Karpathenvorland), Inowrocław, Ciechocinek-Zdrój (mittel-polnische Tiefebene), Połczyn-Zdrój (Moränen-Hügellandschaft) und Kołobrzeg (Ostseeküste) erfasst worden.

Einige Klimacharakteristiken einzelner Kurorte stammen auch vom Arbeitskreis des Staatlichen Hydro-Meteorologischen Instituts. Dieser hat die Klimaverhältnisse von Zakopane - mit Berücksichtigung des polnischen Teiles der Hohen Tatra und des Vortatragebietes-, ferner die Klimacharakteristiken von Rabka, Piwniczna (Karpathenbergland), Polanica (Sudeten) sowie der polnischen Ostseeküste bearbeitet.

In allen klimatographischen Charakteristiken schenkt man der Biodynamik einzelner Klimaelemente eine spezielle Aufmerksamkeit.

V. ARBEITEN AM LOKALKLIMA FUER DEN BEDARF DER MEDIZIN UND DER STAEDTEBAUPLANUNG

DAS LOKALKLIMA DER KURORTE

Die Forschungsarbeiten am Lokalklima der Kurorte gehen in zwei Richtungen: 1. der wissenschaftlichen und 2. der praktischen:

1. In wissenschaftlicher Hinsicht bearbeiten das Lokalklima der Kurorte:
   (a) das Institut für Balneologie und Klimatologie, das bereits Untersuchungen in Kołobrzeg, Miedzyzdroje, Krynica Morska und Rymanów-Zdrój durchgeführt hat, sowie
   (b) die klimatische Abteilung des Geographischen Instituts der Polnischen Akademie der Wissenschaften, die eine Monographie des Lokalklimas vom Kurort Ciechocinek bearbeitet hat.
2. Für praktische Zwecke, z.B. für die Planung und Raumbewirtschaftung der Kurorte, werden klimatologische Gutachten vom speziell dazu berufenem Physiographischen Staatsunternehmen "Geoprojekt", welches dem Ministerium für Städte- und Siedlungsbau untersteht, bearbeitet.

DIE ARBEITEN AM LOKALKLIMA DER STAEDTE

Diese Arbeiten führt man für den Bedarf der kommunalen Wirtschaft, also der Planung und Raumbewirtschaftung. Sie werden angeregt und finanziert vom Forschungsinstitut für Städtebau und Architektur in Warszawa.

Die Studien am Klima der Städte und der Siedlungen werden von folgenden Forschungsstellen betrieben:

1. vom Lehrstuhl für Meteorologie und Klimatologie an der Universität in Łódź, der augenblicklich das Klima und Bioklima folgender Industriestädte bearbeitet: Łódź, Tomaszów Mazowiecki und Zgierz;
2. vom Lehrstuhl für Meteorologie und Klimatologie der Universität in Lublin, der das Lokalklima dieser Stadt bearbeitet;
3. vom Staatlichen Hydro-Meteorologischen Institut in Warszawa, welches das Stadtklima von Kraków bearbeitete und auszerdem sich an den Klimaforschungsarbeiten der Städte des oberschlesischen Industriegebietes beteiligte.
4. Das Lokalklima der Städte und Siedlungen gehört auch zu den Arbeitsproblemen des Lehrstuhls für Regionale Planung der Architektonischen Fakultät an der Technischen Hochschule zu Gdańsk. Aus diesem Institut stammt auch eine recht interessante Bearbeitung des Lokalklimas der Stadt Gdynia.
5. Gewisse Arbeiten an dem Lokalklima der Städte, jedoch ohne tiefer greifende wissenschaftliche Unterlage verfertigt auch das Physiographische Staatsunternehmen "Geoprojekt" in Warszawa.

An den Problemen der Lufthygiene in den Städten dagegen arbeiten speziell dazu berufene mikroklimatische Arbeitszellen an den städtischen und provinzionellen Sanitäts-Epidemiologischen Stationen. Die wissenschaftliche Betreuung übernimmt das Staatliche Hygiene-Institut in Warszawa.

UEBER DEN STAND DER AGRARMETEOROLOGISCHEN FORSCHUNG IN DER DEUTSCHEN DEMOKRATISCHEN REPUBLIK

von

Prof. Dr. A.Mäde (D.D.R.)*

Mit diesem Bericht wird eine bibliographische Zusammenstellung vorgelegt, die agrarmeteorologische Beiträge aus den Jahren 1953 bis 1958 enthält. Bei der Zusammenstellung wurde Wert darauf gelegt, möglichst alle Veröffentlichungen zu erfassen, in denen über agrarmeteorologische Arbeitsergebnisse aus den wissenschaftlichen Institutionen in der Deutschen Demokratischen Republik berichtet. Bei einer Beschränkung auf die im Gebiet der DDR verlegten Druckereierzeugnisse wäre ein Ueberblick über den Umfang der Forschungsarbeiten auf dem Gebiete der Agrarmeteorologie nicht vollständig gewesen. Es muszten daher auch die Beiträge aufgenommen werden, die in anderen Publikationsorganen erschienen sind.

Stellt man der alphabetischen Ordnung nach dem Verfassernamen eine Gliederung nach den Institutionen gegenüber, in denen die Untersuchungen durchgeführt wurden, so erhält man einen Ueberblick über die Struktur der agrarmeteorologischen Forschung in der D.D.R.

Die Probleme der Agrarmeteorologie als einem Grenzgebiet zwischen der Biologie und der Meteorologie werden naturgemäsz von Wissenschaftlern beider Disziplinen bearbeitet. Von Seiten der Meteorologie ist eine starke Förderung durch den Meteorologischen und Hydrologischen Dienst der D.D.R. zu verzeichnen. Ein Forschungsinstitut für Agrarmeteorologie dieses Dienstes arbeitet unter Leitung des Berichterstatters in Halle. Zu seinem Arbeitsbereich gehören die agrarmeteorologischen Forschungsstationen in Grosz-Lüsewitz, Müncheberg (Mark), Aschersleben, Dresden-Pillnitz, Marquardt und Potsdam-Bornim. Es gehörte eine zunächst weitere Station in Quedlinburg dazu, die im Jahre 1954 in das Institut für Pflanzenzüchtung der Deutschen Akademie der Landwirtschaftswissenschaften als Abteilung dieses Instituts übernommen wurde.

In diesem Netz agrarmeteorologischer Forschungsstützpunkte werden in enger Zusammenarbeit mit Instituten der Deutschen Akademie der Landwirtschaftswissenschaften Probleme bearbeitet, die von einer einzelnen Fachrichtung, der Meteorologie oder der Agrarwissenschaft, nur unvollkommen gelöst werden können.

Seit mehr als 10 Jahren wird an diesen Stellen die kollektive Arbeitsweise praktiziert. Veröffentlichungen aus diesem Bereich liegen von folgenden Mitarbeitern vor: Fusz, F., Hoffmann,K., Koitsch, R., Mäde, A., Raeuber, A., Schmidt, M., Schrödter, H.

Der Meteorologische und Hydrologische Dienst besitzt für den Sektor der humanen Bioklimatologie eine ähnliche Forschungseinrichtung. Ueberschneidungen zwischen Agrarmeteorologie und humaner Bioklimatologie sind nicht zu vermeiden. So liegen aus dem Bereich des Forschungsinstituts für Bioklimatologie in Berlin-Buch und seinen Forschungsstationen von Hentschel,G., Kühn, G., Mrose, H., Wagner, H., und Zenker, H. Arbeitsergebnisse vor, die mit in diese agrarmeteorologische Bibliographie aufgenommen werden können.

Aus anderen Institutionen des MHD sind Arbeiten vorgelegt worden, die für den Agrarmeteorologen ebenfalls von Interesse sind. Als Verfasser seien genannt: Gelbke,W.,Hinzpeter,H., Matzke, H., Seyfert, F., Skeib, G. und Vilkner, H.

In einer Reihe von Instituten der Deutschen Akademie der Landwirtschaftswissenschaften wird ebenfalls zu agrarmeteorologischen Problemen Stellung genommen. Vor allem von den Instituten für Pflanzenzüchtung sind wertvolle Beiträge vorgelegt worden. Als Bearbeiter sind zu nennen : Athenstädt, H., Dahse, F., Engel, K.H., Junges, W., Krümmel, H., Löhrke, L.,Müller,H.J.,Pechert, H., Scholz, K., Sörgel, G., Unger, K., Vogel, G., Werner, K. Aus dem Bereich der von der Akademie betreuten Institute der ehemaligen Biologischen Zentralanstalt für Land- und Forstwirtschaft berichteten Hoffmann, G., Klemm, M., Kirchner, H.A., Müller, F.P. und Richter, G.

Im Bereich der Universitäten sind die meteorologischen und agrarmeteorologischen Institute durch Veröffentlichungen von Hesse, W., Koch, H.G., Pfeifer, F. und Stenz, S. vertreten. Von geographischer Seite haben sich Bauer, L., Reinhard, H. und Schulze, J.H. geäuszert. In groszem

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Umfang legten die land- und forstwirtschaftlichen Institute der verschiedenen Universitäten Bearbeitungen agrarmeteorologischen Inhalts vor. An Mitarbeitern sind aus den einzelnen Universitäten zu nennen:

HUMBOLDT-UNIVERSITAET BERLIN: Baumann, H., Casperson, G., Ehwald, E., Fröhlich, H., Göhre, K., Hennebo, D., Illner, K., Olbertz, M.H., Richter, P., Schulze, J., Schumann, A., Weber, H., Wilamowitz-Moellendorf und Zillmann, K.H.

MARTIN - LUTHER - UNIVERSITAET HALLE-WITTENBERG: Bauckmann, H., Dörter,K.,Friedrich,G.,Meier,G.

FRIEDRICH - SCHILLER- UNIVERSITAET JENA: Baltzer, H.,Bergmann, W., Kretzschmer, G., Matzner, F. und Rust, G.

KARL-MARX - UNIVERSITAET LEIPZIG: Britz, L., Fröhlich, G., Geiler, H., und Quass, R.

UNIVERSITAET ROSTOCK: Bauer, F. und Bochow, H.

PAEDAGOGISCHE HOCHSCHULE POTSDAM: Müller-Stoll, W.R. und Steubing, L.

Zu Fragen des Wasserhaushalts liegen Mitteilungen aus der TECHNISCHEN HOCHSCHULE DRESDEN (Busch, K.F.) und dem INSTITUT FUER WASSERWIRTSCHAFT (Kalweit, H., und Täumer, F.) vor.

Ueberblickt man die Thematik der Publikationen, so ist festzustellen, dasz den für die agrarmeteorologische Forschung grundlegenden methodischen Problemen grosze Beachtung geschenkt wurde. Dies gilt sowohl für den Sektor der Mesztechnik als auch für den der Bearbeitung der Meszwerte. In zunehmendem Masze werden dabei moderne statistische Prüfmethoden angewandt.

Einen groszen Raum nehmen die Berichte über die Zusammenhänge zwischen Witterung und Pflanzenkrankheiten oder Pflanzenschädlingen ein. Das Ziel dieser Untersuchungen ist es, Unterlagen für den Aufbau eines Schädlingswarndienstes zu schaffen.

Dem Wasserhaushalt landwirtschaftlicher Kulturen und dem Einflusz der Witterung auf das Pflanzenwachstum und den Ertrag wird ebenfalls grosze Aufmerksamkeit gewidmet. Diese Untersuchungen streben in zunehmendem Umfang einen auch vom Standpunkt der Statistik her gesicherte Aussagewert der Ergebnisse an. Sie benutzen simultan phänometrische und meteorologische Beobachtungen, die korrelationsanalytisch bearbeitet werden.

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VERZEICHNIS DER ABKUERZUNGEN.

Abh.Met.u.Hydrolog.Dienst der DDR	Abhandlungen des Meteorologischen und Hydrologischen Dienstes der DDR.
Angew.Met.	Angewandte Meteorologie
Ann.d.Met.	Annalen der Meteorologie
Arch.f.Forstwesen	Archiv für Forstwesen
Arch.f.Gartenbau	Archiv für Gartenbau
Arch.f.Met.,Geoph.u.Biokl.	Archiv für Meteorologie, Geophysik und Bioklimatologie
Ber.d.Dt.Botan.Ges.	Berichte der Deutschen Botanischen Gesellschaft
Der Züchter	Der Züchter
Dt. Gartenbau	Der Deutsche Gartenbau
D.Dt.Landwirtsch.	Die Deutsche Landwirtschaft
Die Gartenbauwissenschaft	Die Gartenbauwissenschaft
D.Naturwiss.	Die Naturwissenschaften
Forsch.u.Fortschr.	Forschungen und Fortschritte
Nachr.-Bl.f.d.Dt.Pflanzenschutzdienst	Nachrichtenblatt für den Deutschen Pflanzenschutzdienst.
Planta	Planta - Archiv für wissenschaftliche Botanik
Sitz.-Ber.Dt.Akad.Landwirtschaftswiss.Berlin	Sitzungsberichte der Deutschen Akademie der Landwirtschaftswissenschaften zu Berlin.
Umschau	Umschau in Wissenschaft und Technik
Veröff.d.Inst.f.Agrarmet.d.Univ.Leipzig	Veröffentlichungen des Instituts für Agrarmeteorologie der Universität Leipzig
Wasser u. Boden	Wasser und Boden
Wasserwirtsch.-Wassertechn.	Wasserwirtschaft - Wassertechnik
Wiss.Z.Humboldt-Univ.Berlin,Math.-Nat.Reihe	Wissenschaftliche Zeitschrift der Humboldt- Universität Berlin, Mathematisch-Naturwissenschaftliche Reihe.
Wiss.Z.Univ.Greifswald,Math.-Nat. Reihe	Wissenschaftliche Zeitschrift der Universität Greifswald, Mathematisch - Naturwissenschaftliche Reihe.
Wiss.Z.Univ.Jena, Math.-Nat. Reihe	Wissenschaftliche Zeitschrift der Universtät Jena, Mathematisch-Naturwissenschaftliche Reihe.
Wiss.Z.Univ.Leipzig, Math.-Nat. Reihe	Wissenschaftliche Zeitschrift der Universität Leipzig, Mathematisch-Naturwissenschaftliche Reihe.
Wiss.Z.Univ.Rostock	Wissenschaftliche Zeitschrift der Universität Rostock.
Z.f.Acker-u. Pflanzenbau	Zeitschrift für Acker- und Pflanzenbau.
Z.angew.Zool.	Zeitschrift für angewandte Zoologie
Z.f.Met.	Zeitschrift für Meteorologie
Z.f. Pflanzenbau u. Pflanzenschutz	Zeitschrift für Pflanzenbau und Pflanzenschutz.
Z.f. Pflanzenzüchtung	Zeitschrift für Pflanzenzüchtung.

Section D : Requests from members and general information

Section E : Requests from non-members

Section F : Book reviews

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section F: Book Reviews*

L. AARIO AND H. JANUS : BIOLOGISCHE GEOGRAPHIE (DAS GEOGRAPHISCHE SEMINAR) - Georg Westermann Verlag, Braunschweig 1958, with 7 illustrations, 3 tables, 136 pages. Price 5.80 German marks.

This booklet is a recent issue of the series "Geographical Seminar" published by the Georg Westermann Verlag. It gives a summary of the geographical distribution of plants (by Prof. Aario, Helsinki, Finland) and of animals (by Dr. Janus, Stuttgart, Germany) and of the various factors affecting this distribution, one group being climatological factors. Although the booklet is primarily intended for students of Geography, Zoology and Botany, it provides interesting reading for every bioclimatologist, the more so as it discusses the possible effect of environment on permanent changes in the living organism.

H. BERG : SOLAR-TERRESTRISCHE BEZIEHUNGEN IN METEOROLOGIE UND BIOLOGIE - Akademische Verlagsgesellschaft Geest & Portig K.-G., Leipzig 1957, With 77 diagrams, 200 references, 172 pages.

This book is published as volume 30 of the series "Probleme der Kosmische Physik" (Problems of Cosmic physics) by H. Berg, Professor of Meteorology and Geophysics at the University of Köln, Germany and Vice President of the Internat.Soc.Bioclim. Biomet.
Bioclimatologists should be grateful to Prof. Berg that he has been prepared to summarise the vast amount of publications on this subject of which a very large part lacks any scientific or statistical basis. As a result most scientists are inclined to reject automatically any new publication in this field. Prof. Berg's objective, but at the same time very critical study of the problem gives an excellent summary of all these publications, and clearly indicates which conclusions should be rejected or accepted and which problems require further study.
The book can be highly recommended to bioclimatologists interested in the problem of the possible relationship between cosmic events, weather, climate and biological phenomena.

E. BUNNING : DIE PHYSIOLOGISCHE UHR - Springer-Verlag, Berlin, Göttingen, Heidelberg 1958, with 107 diagrams, 105 pages, price 24 German marks.

Many bioclimatological phenomena observed both in man and animal seem, at least partly, to be caused by the disturbing effect of weather and climate on the endogenous biological rhythm of living organisms. The problems of Biological Rhythms should therefore be included in many bioclimatological studies.
Many workers in the field of Biological Rhythms (united in the Int. Soc. of Biological Rhythm, Secretariat: Dr. A. Sollberger, Dept. of Anatomy, Karolinska Inst., Solnavägen 1, Stockholm 60, Sweden) are often only interested in rhythmic phenomena observed in their own specific field of research, either zoology, botany etc. It is often not sufficiently realized that many of these phenomena in various groups of organisms are closely related to each other.
Prof. Bünning, a well known botanist by profession, has tried to unite these various principles, in a booklet called "Physiological Time". The book is based on a series of lectures, held in the USA (1956) and London (1958). The many diagrams, extensive list of references and clear style make this booklet a valuable guide for bioclimatologists interested in this aspect of Bioclimatology.

J.L. CLOUDSLEY-THOMPSON : SPIDERS, SCORPIONS, CENTIPEDES AND MITES (THE ECOLOGY AND NATURAL HISTORY OF WOODLICE, 'MYRIAPODS' AND ARACHNIDS) - Pergamon Press, I.R. Maxwell and Co. Ltd., London, 1959, price 50 shillings.

This book by Cloudsley-Thompson, member of the Executive Board of ISBB, discusses various aspects of Entomological Bioclimatology. Although there are a number of works on the morphology and systematics of many of these animals, there is no readily accessible account of their ecology and natural history. In these days of specialization the combination of physiology with ecology and a study of the influence of microclimates is an especially useful type of approach. This book consists of a number of chapters devoted to different groups of animals, the chapters themselves consisting of a brief outline of the classification and distribution of the group, followed by detailed accounts of their general behaviour, food and feeding habits, enemies (predators and

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* Titles of reprints of articles received from members since 1956, will be given in the following issues of the Journal.

parasites), courtship and mating habits, reproduction and growth stages. It is documented with bibliographies that also contain references to publications that can be used for the identification of specimens and supplied with a glossary and indexes.
Various tropical groups, such as scorpions and Solifugae not represented in temperate regions, are included not only for completeness, but because they are of interest for purposes of comparison and will make the book useful to university students, research workers and amateur naturalists in all parts of the world.

E. GAGEL : DIE SIEBER MEERE - Georg Westermann Verlag, Braunschweig 1958, with 41 photographs, 105 diagrams, 18 tables, 236 pages.

This well illustrated book on marine hydrology does not pretend to be a textbook. It gives in simple language a good summary of various aspects of modern marine hydrology, although in the section on submarine canyons we missed the modern theories and experiments on turbidity currents. It discusses the effect of weather and climate on sea currents and their biological effects. The book can be recommended to bioclimatologists, in particular those interested in general problems of marine bioclimatology.

F. LAUSCHER, M. ROLLER, G. WACHA, M. GRAMMER, E. WEISS AND J.W. FRENZEL : WITTERUNG UND KLIMA VON LINZ - Sonderheft VI, Zeitschrift "Wetter und Leben", vol. X, 1958, with 21 illustrations, 30 tables and 235 pages.

This publication was prepared at the request of the "Kulturamt" of the city of Linz and represents a complete analysis of the meteorological and climatological data of the city which are required for the study of various problems in relation to urban bioclimatology. For example, airpollution is a very important problem in this industrialized city with its days of heavy fog. Members working in the field of Urban Bioclimatology are recommended to study this interesting publication.

LOCUSTA NO. 6 : BULLETIN OF THE INTERNATIONAL AFRICAN MIGRATORY LOCUST ORGANIZATION 1959.

The latest issue received contains three interesting articles by:
G.B. Popov : Ecological studies on oviposition by Locusta migratoria migratorioides (R. & F.) in its outbreak area in the French Sudan.
V.M. Dirsh : The early stages of Gastrimargus nigericus Uvarov 1926 (Acridoidea, Orthoptera).
A. Shulov and M.P. Pener : A contribution to knowledge of the development of the egg of Locusta migratoria migratorioides (R. & F.).
Members interested in this aspect of Entomological Bioclimatology are also recommended to study previous issues:
vol. 1 (July 1954) : B. Zolotarevsky - Historique de l'Organisation internationale de lutte préventive contre le Criquet migrateur africain.
vol. 2 (October 1954) : G. Remaudière - Étude écologique de Locusta migratoria migratorioides Rch. & Frm. (Orth., Acrididae), dans la zone d'inondation du Niger en 1950.
vol. 3 (February 1955) : J.T. Davey - A preliminary note on seasonal movements of the African Migratory Locust in the Solitary Phase.
vol. 4 (November 1956) : F.O. Albrecht - Limitation des effectifs chez un Acridien : Influence de la sécheresse du sol sur les oeufs de Nomadacris septemfasciata (Serv).
J.S.B. Choudhuri - Experimental studies on the selection of oviposition sites of Locusta migratoria migratorioides (R. & F.).
vol. 5 (December 1957) : J.T. Davey - The African Migratory Locust (Locusta migratoria migratorioides Rch. & Frm., Orth.) in the Central Niger delta Part One, Climate and Vegetation.

S.W. TROMP : THE GEOGRAPHICAL DISTRIBUTION OF ARTERIOSCLEROTIC HEART DISEASES IN THE NETHERLANDS (PERIOD 1936-1945) - Bioclimatological Research Centre, Leiden, vol. III, 20 November 1958, with 7 maps, 3 graphs, 8 tables, 12 pages.

On the basis of mortality data in the different municipalities in the Netherlands (standardized for age and number of inhabitants) a number of geographical distribution maps were prepared which indicate high mortality in the 5 coastal provinces and relatively low values in the Eastern provinces. The inhabitants of these coastal provinces do not differ specifically in food habits from those of the Eastern provinces. These and various other considerations make it unlikely that differences in food could explain the observed geographical distribution. The possible influence of weather and climatic differences between the Eastern and coastal provinces are discussed and their possible effect on arteriosclerotic diseases.

S.W. TROMP : THE GEOGRAPHICAL DISTRIBUTION OF CANCER OF THE LUNG IN THE NETHERLANDS (PERIOD 1936-1952) - Bioclimatological Research Centre, Leiden, vol. IV, 6 January 1959, with 5 maps, 15 tables, 10 pages.

The geographical distribution of lung cancer mortality in a standardized population is represen-

ted in a number of maps. A very peculiar geographical distribution is found which cannot be explained by differences in smoking habits or air pollution. The areas with high lung cancer mortality are roughly opposite to those with high Bronchitis-Pneumonia mortality. The boundary, a S.W.-N.E. line in the Netherlands, roughly coincides with a climatic boundary; i.e. west of this line (nearer to the coast) low Bronchitis-Pneumonia mortality occurs, east of this line high mortality values are observed. This boundary is neither a racial or food boundary, or related to different medical facilities east and west of it. The influence of climate seems therefore possibly the cause of the observed distribution.

S.W. TROMP : BIOMETEOROLOGICAL ANALYSIS OF DAILY AND MONTHLY VARIATIONS IN RESTLESSNESS AND ILL-TEMPEREDNESS OF MENTAL PATIENTS IN THE WESTERN PART OF THE NETHERLANDS (PERIOD 1 NOVEMBER 1956 - 1 DECEMBER 1958).
First report: Psychiatric Institute "Hulp en Heil" (at Leidschendam)- Bioclimatological Research Centre, Leiden, vol. V, 5 April 1959, with 25 charts, 28 pages.

This publication represents the first report on data collected in one of seven large Psychiatric Institutes in the Netherlands cooperating in this project. Apart from monthly and pseudoseasonal variations, it was found that restlessness of Schizophrenic patients increases with influx of warm air masses; in Epileptic patients a decrease was observed. In Epileptic patients both general motoric restlessness and number of epileptic attacks increases with influx of cold airmasses. A mathematically significant correlation was found with cold front passages.
Electrophoretic serum protein studies of mental patients showed characteristic deviations in Schizophrenics which were less pronounced or absent in other groups of mental patients.

H. WILHELMY : KLIMAMORPHOLOGIE DER MASSENGESTEINE - Georg Westermann Verlag, Braunschweig 1958, with 137 illustrations, 385 references and 238 pages, price 35.80 German marks.

Prof. Wilhelmy of the Dept. of Geography of the Technical University of Stuttgart has prepared an interesting book with many original photographs on the influence of the microclimate on soil and topography. Whereas around 1925 geomorphologists were inclined to overestimate the effect of movements of the earthcrust (tectonics) on the topography of the earthcrust, in recent years the great importance of weather and climate on soil topography is becoming appreciated more and more.
R. Geiger in his wellknown book "Das Klima der bodennahen Luftschicht" discussed mainly the effect of soil topography on the microclimate of an area. The effect of this microclimate on soil is generally a less common field of study. Although strictly speaking this subject does not belong to bioclimatology sensu stricto, it is felt that it is essential for agro- and forest meteorologists to be acquainted with the effect of microclimate in soil. For this group of bioclimatologists particularly Wilhelmy's book is an easy guide to the various problems in this field.
The printing of many less known pictures of rock morphology is refreshing as many textbooks continue to reproduce only the same internationally known geomorphological points of interest.

GUIDE BOOK TO RESEARCH DATA FOR ARID ZONE DEVELOPMENT (ARID ZONE RESEARCH VOL. IX) - Unesco Publication (Edited by B.T. Dickson), 1957, 191 pages.

This excellent summary of research data required for arid zone development projects consists of the following parts and chapters:

Part I: Physical and Biological factors.

- Chapter 1 : Introduction (by B.T. Dickson, Botanist, former Chief Division of Plant Industry, CSIRO, Australia).
- Chapter 2 : Mapping (by F. George, Agricultural Officer, FAO, Rome).
- Chapter 3 : Climatology (by E.G. Bilham, formerly Deputy Director of the Meteorological Office, London).
- Chapter 4 : Geology and geophysics (by E. Sherbon Hills, Professor of Geology and Mineralogy, University of Melbourne, Australia).
- Chapter 5 : Geomorphology (by C.S. Christian, Officer-in-charge, Land Research and Regional Survey Section, CSIRO, Australia; J.N. Jennings, Reader, Dept. of Geography, Australian National University, Australia; C.R. Twidale, Geomorphologist, Land Research and Regional Survey Section, CSIRO, Australia.
- Chapter 6 : Hydrology (including irrigation) (by J. Tison, Secretary General of the International Association of Hydrology).
- Chapter 7 : Soil Resources (by Herbert Greene, Adviser on Tropical Soils, Colonial Office, United Kingdom).
- Chapter 8 : Vegetation (by W.G. McGinnies, Director of the Central States Forest Experiment Station, Colombus, Ohio, USA).
- Chapter 9 : Forests (by M. Leloup, Head, Forestry Division, FAO, Rome).

Part II: Human factors.

- Chapter 1 : Population (by E. Sergent).
- Chapter 2 : Land tenure (by E.H. Jacoby, Land Tenure Specialist, FAO, Rome).
- Chapter 3 : Animal Husbandry (by R.O. Whyte, Agriculture Division, FAO, Rome).
- Chapter 4 : Nutrition, health and sanitation (by WHO).
- Chapter 5 : Sources of energy (by E.W. Golding).

Other publications in the same arid zone series are:

vol. I : Reviews of Research on Arid Zone Hydrology.

vol. II : Proceedings of the Ankara Symposium on Arid Zone Hydrology.

vol. III : Directory of Institutions Engaged in Arid Zone Research.

vol. IV : Utilization of Saline Water. Reviews of Research.

vol. V : Plant Ecology. Proceedings of the Montpellier Symposium.

vol. VI : Plant Ecology. Reviews of Research.

vol. VII : Wind and Solar Energy. Proceedings of the New Delhi Symposium.

vol. VIII : Human and Animal Ecology. Reviews of Research.

vol. X : Climatology. Reviews of Research.
This volume contains the eight following reports, together with a large bibliography: "Evaporation and the water balance", by E.L. Deacon, C.H.B. Priestly and W.C. Swinbank; "Climatic factors in arid zone animal ecology", by F.S. Bodenheimer; "Radiation and the thermal balance", by A.J. Drummond; "Climates and vegetation", by A. Vernet; "Proprioclimates of man and domestic animals", by D.H.K. Lee; "The modification of microclimates", by E.M. Fournier d'Albe; "The chemical climate and saline soils in the arid zones", by E. Eriksson; "Climatological observational requirements in arid zones", by M. Gilead and N. Rosenan.

vol. XI : Climatology and microclimatology: proceedings of the Canberra Symposium.
This volume contains the 50 papers presented to the symposium: each paper is given in its original language, followed by a summary in the other language.
The papers are grouped in the following eight sections, each of which concludes with an analytical summary of the discussions: "Evaporation and the water balance"; "Radiation and the thermal balance"; "Interrelationships of climatic factors and flora"; "Interrelationships of climatic factors and fauna"; "Microclimate of man and domestic animals"; "Modification of microclimates"; "Salting and chemistry of rainwater"; "Climatological observational requirements in arid zones".

Section G : International Organizations (WMO, FAO, WHO, etc.)

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section G: International Organizations (Unesco)

RECENT ARID ZONE PROJECTS

1. UNESCO-SPAIN SYMPOSIUM ON PLANT-WATER RELATIONSHIPS IN ARID AND SEMI-ARID CONDITIONS:

A Symposium on Plant-Water Relationships in Arid and Semi-Arid Conditions, organized jointly by the Spanish Government and Unesco, will be held in Madrid from 24 to 30 September 1959. This meeting should provide an opportunity for a number of scientists to present and discuss scientific papers on original research.

PROGRAMME:
Methodology of water relation studies on plants.
Water sources for plants.
Water balance of plants under arid and semi-arid conditions.
Drought-resistance of plants.
Practical applications to agronomy.

2. ECOLOGICAL MAP OF THE MEDITERRANEAN AREA

At the proposal of the Food and Agriculture Organization's Forestry Division, the Unesco Advisory Committee on Arid Zone Research recommended, at its thirteenth session, the organization of a meeting of experts on plant ecology for the purpose of studying the preparation of an ecological map for the Mediterranean area.
Following this recommendation, an FAO/Unesco Study Group was set up and met in Paris from 5 to 9 January 1959.

While maintaining "Ecological Map of the Mediterranean Area" as the title of the project, the Study Group decided to consider an area extending beyond the Mediterranean zone proper, and to map regions located approximately between the twentieth and forty-eighth parallels, excluding however the mountains of the northern portion, and stretching from the Atlantic to the Indus river. This delimitation would have the advantage of including almost the entire region in which activities under Unesco's major project are concentrated.

The Study Group, taking into account the international aim pursued, the number of maps available and financial considerations, decided to select a scale of 1/5,000,000. On this small scale it is possible to obtain very accurate overall perspectives for the study of the development of the countries concerned. Furthermore, this scale has the advantage of expediting map compilation. Because of the scale selected, the group proposed to draw up two maps - a bioclimatic map and a vegetation map.

BIOCLIMATIC MAP. The bioclimatic map will be drawn up by the ombrothermic curve method described by Mr. Gaussen, taking into account, if possible, the number of rainless days. The sites covered by this map will be selected on the basis of data furnished by Mr. Emberger's method, and the combination of these two methods will make a more accurate subdivision of the bioclimatic regions possible. This general map will be supplemented by bioclimatic maps on a smaller scale for the regions of Australia, South Africa and America with analogous climatic conditions. This work, undertaken by Messrs. Gaussen and Emberger, will be completed by a documentation reference notice giving the rainfall and temperature curves, the absolute values used and an explanation of the methods employed.

VEGETATION MAP. This map will represent the climatic vegetation, indicating by different colours the fundamental forest stages and the various types of steppe formations.
Against this coloured background will be shown, in so far as possible, the condition of present-day vegetation, considering particularly the most valuable vegetation species or groups of species. As in the case of the bioclimatic map, this map will be supplemented by small reduced-scale maps showing the climatic vegetation of the homologous regions of the other parts of the world.

Preliminary work. While awaiting the drawing up of the complete bioclimatic map, the Study Group requested Messrs. Gaussen and Emberger to prepare immediately a preliminary general map on a scale of 1/5,000,000 accompanied, as example, by the final maps (bioclimatic and vegeta-

Note: Copied from "Arid Zone", Newsletter about Unesco's Major Project on Scientific Research on Arid Lands (published by Unesco), no. 3, March 1959.

tion) of Morocco. This work will serve as a basis for discussion of the final complete map.

The Study Group was perfectly aware of the obviously limited possibilities of a map on a scale of 1/5,000,000 and recommended to FAO and Unesco that they frame a programme for the preparation of maps on a scale 1/1,000,000 against the international background of the region considered, in conjunction with projects for compiling other maps, particularly soil maps, on a scale of 1/1,000,000. These 1/1,000,000 scale maps are absolutely essential for adequate knowledge of actual and potential land use conditions.
A convincing illustration of the value of such 1/1,000,000 maps is given by the plant cover map of Tunisia, which was presented to the Study Group with the accompanying report drawn up by Messrs. Gaussen and Vernet.
This map, printed over the international 1/1,000,000 scale map, shows the following:

1. Present permanent or temporary crops, with statistical indications enabling basic information to be shown on the map (for instance, one symbol representing 25,000 olive trees,etc.), are shown by means of contour lines established with the aid of aerial photographs.
2. Natural vegetation of three types is also shown by contour lines drawn from aerial photographs: forests shown in flat tint, scrub vegetation in lines, and herbaceous vegetation by dotted lines.
3. The basic idea being that of the "vegetation successional stage" (beech stage, holm - oak stage, etc., named according to the climax formation), and the successional stage being dependent on ecology, each stage is designated by a colour which thus represents an ecological value.
4. Alongside the principal map are the following small maps, on a scale of 1/5,000,000, giving numerous supplementary details: a hypsometric map; a geological or soil map; a botanical map indicating the manner in which the vegetation would evolve if men were eliminated; an administrative map; a climatic map; a land use map.

Many details are given in an appendix, as is also an analysis of the requisites for the development of the region involved.
It must be noted that, in order to cover on a scale of 1/1,000,000 the regions of the Mediterranean area defined above, some 45 different maps would have to be published for the vegetation alone. Such a programme could be carried out only as the result of considerable efforts by the countries concerned, in conjunction with wide-scale international action such as that envisaged by the new United Nations Special Fund for Economic Development.

3. FAO-UNESCO DESERT LOCUST ECOLOGICAL SURVEY

The first meeting of the Inter-Agency Working Group established to advise on the conduct of the FAO/Unesco Desert Locust Ecological Survey was held at the Anti-Locust Research Centre, London, from 11 to 13 February 1958. That meeting outlined the general problem, the objectives of the survey and planned the first survey in the summer breeding areas of the desert locust in the Sudan and Chad Territory.
The second meeting was convened at Unesco Headquarters in Paris on 29 and 30 December 1958 to review the results of the first survey and to plan further operations.

The meeting received an outline report of the first survey which was conducted in Sudan, Chad Territory and Northern Ethiopia from 18 June to 21 November 1958. This report will be circulated to all interested governments and organizations as soon as it is completed.

After examining possible areas for spring/summer surveys, the meeting recommended that the next survey should be undertaken in the Republics of Mauretania, Sudan and Niger.
This selection was influenced by the offer of Messrs. Frézal and Mallamaire to submit to their respective administrations proposals with a view to securing their full cooperation and assistance, particularly in loaning vehicles, equipment and technical staff to accompany the survey. The Survey Team assembled at Dakar at the end of February to prepare for proceeding to the field at the beginning of March. It is envisaged that the survey, commencing in Mauratania and later working eastwards, will continue its work in West Africa until about September.
Owing to the importance of the Arabian peninsula in the desert locust problem, the meeting considered that this area should be the next objective for a survey during the winter and spring of 1960 if it were found practicable. It was also felt that it might be desirable at that time for the plant ecologist to return to an area previously visited in order to study the state of the vegetation at different times of the year.

4. UNESCO-WMO EXPERT MEETING ON SOLAR RADIATION PROBLEMS

Following on the recommendations of the Advisory Committee on Arid Zone Research at its fourteenth session, Unesco and WMO organized a meeting of experts on solar radiation in order to set up detailed plans for the following two projects:

1. A climatological survey of solar radiation in arid zones.
2. The development of a simple, robust and cheap solar radiation recorder for the utilization of solar energy.

The meeting was held at the WMO Secretariat in Geneva from 25 to 27 February 1959, under the chairmanship of Dr. W. Mörikofer, Director of the Physical Meteorological Observatory, Davos.

The meeting first studied in general terms the role of radiation measurement in the context of research activities on arid zone problems. Although the immediate interests of such measurements in arid zones would be in applied research, the group agreed that basic research on climatological problems of radiation should have priority within the Unesco programme, since a thorough knowledge of radiation and its related problems was essential to any balanced programme of research on arid zones.
These general considerations were followed by a more detailed discussion of the following radiation problems which are of evident importance for applied research: (a) utilisation as a source of energy; (b) effects on soil conditions; (c) effects on plant cover; (d) effects on humans and animals; (e) heat balance (short and long-wave radiation).

The group went on to discuss details of the proposed survey of existing radiation data. It agreed that the survey should cover the whole region stretching from North Africa and the Middle East to South Asia where the major project activities are concentrated. Where data are scanty, the materials from stations in adjacent and climatologically similar areas will also be used.

Recommendations were made as to the kind of data necessary for the survey and the possible sources. It was agreed that the work will be done mainly at the Davos Observatory by a young research worker with experience in radiation measurements and an assistant, the whole project being under the supervision and guidance of Dr. Mörikofer. Close contact with the Secretariat of WMO will be maintained, especially since it is through WMO that most of the material from the files of meteorological institutes will be collected, including those resulting from observations during the International Geophysical Year.

5. A REGIONAL COURSE ON PLANT ECOLOGY IN SOUTH ASIA

In the framework of the major project, a regional training course on plant ecology, organised by the Unesco Science Co-operation Office for South Asia with the assistance of the Indian authorities, took place at Jaipur (India), from 3 to 21 December 1958. It was similar to the course organized earlier in 1958 in the U.A.R. (Egypt). This course was intended to inform research workers and specialists in the governmental services concerned about the latest developments of ideas and practical methods of plant ecology. The course was placed under the direction of Professor L. Emberger, Director of the Botanical Institute of the University of Montpellier, France.

6. TRAINING ARID ZONE SPECIALISTS

A regional course on microclimatology, jointly organized by the Pakistan Meteorological Service and the Unesco Science Co-operation Office for South Asia, will be given this summer at Quetta, at the Geophysical Research Institute. This course, which will last one month, will comprise a series of lectures on the various aspects of microclimatology in arid zones, and practical work in measurement and interpretation of microclimatological data. It will be directed by Mr. R.O. Slatyer, Land Research and Regional Survey Division, CSIRO, Canberra (Australia), with the assistance of Mr. Hoyle, expert of the World Meteorological Organization, who is at present in Iran, and of specialists of the Pakistan Meteorological Service and the other appropriate services. It is expected that approximately fifteen participants from Pakistan and fifteen from the neighbouring countries will be invited to attend this course, which will be a follow-up, on the regional level, of the symposium organized in Canberra in 1956.

7. GENERAL INFORMATION

Prohuza (French Study and Information Centre for Human Problems in the Arid Zones) organized Saharan Medico-Social Information Days in Paris from 9 to 11 April 1959: the proceedings took place in the Unesco Conference Hall. The subjects discussed were biological and psycho-sociological adaptation of man to the desert; hygiene and disease prevention; housing and acclimatization; labour and economy. Numerous French scientists, administrators, doctors and engineers, as well as a number of foreign experts took part in these discussions.

An interesting experiment in irrigation is now being carried out by Messrs. H. and E. Boyko, of the Agricultural Research Station of the Israeli Ministry of Agriculture. Based on observations taken on coastal dunes, this experiment shows that soils of similar high permeability make it possible to cultivate certain salt-resistant species of economic value even when they are irrigated with water which has a high concentration of sodium chloride. The species used in this first experiment, begun in July 1957, are Juncus maritimus Lam. (a valuable cellulose plant) and Agropyrum junceum (fodder plant with a high nutritive value). The success of this method might render it possible to make barren sand dunes and similar soils productive by irrigating them with water having a high salt content, or even with sea water.

8. PUBLICATIONS RECENTLY RECEIVED BY UNESCO

CLIMATE AND MAN IN THE SOUTH-WEST. Proceedings of a symposium, edited by Terah L. Smiley. Tucson, Arizona, The University Press, 1958, 84 pp.

COMMENT CONSTRUIRE AU SAHARA. Cahier du Centre Scientifique et Technique du Bâtiment, 4, avenue du Recteur-Poincaré, Paris-16e, July 1958, 83 pp.
A climatic, architectural and economic study of the problems of building living and office accommodation in a hot dry climate; technical annexes and bibliography.

ECOLOGIE ET PEUPLEMENT ENTOMOLOGIQUE DES SABLES VIFS DU SAHARA NORD-OCCIDENTAL, by F. Pierre. Centre National de la Recherche Scientifique, 13, quai Anatole-France, Paris-7e, 1958, 332 pp. This publication describes research carried out between 1947 and 1953, mainly in the Beni-Abbes region. The first part deals with the origin and distribution of the sands, ecological study, microclimates and biotic factors. The second discusses the entomological population, its varying composition according to the types of sand, its special features and groupings.

FLORE DU SAHARA SEPTENTRIONAL ET CENTRAL, by Paul Ozenda. Centre National de la Recherche Scientifique, 13, quai Anatole-France, Paris-7e, 1958, 488 pp., 16 plates, octavo.
The first part of this book, "Introduction to the botany of the Sahara", begins with a general description of desert conditions, followed by studies on conditions in the Sahara, the composition and origin of the flora of the Sahara, the biology of desert plants, plant communities in the Sahara, and the relation between vegetation and human occupation. The seconf part is an analytical flora for identifying vascular plants in the geographical area covered. It can also be used for most of the species found in the Southern Sahara. A number of drawings and about 15 photographic plates help readers in colsulting the book.

HOMMES ET DESERTS: EVALUATION BIOCLIMATOLOGIQUE DES SITES D'INDUSTRIALISATION AU SAHARA, by Dr. G. Lambert. Centre d'Etudes et d'Information des Problèmes Humains dans les Zones Arides, 31, rue de Bassano, Paris-8e, 1958.

HOMMES ET DESERTS: INFLUENCE DU CLIMAT TROPICAL SUR LE COMPORTEMENT PHYSIOLOGIQUE DE L'HOMME, by R. Lemaire. Centre d'Etudes et d'Information des Problèmes Humains dans les Zones Arides, 31, rue de Bassano, Paris-8e, 1958.

M I S C E L L A N E O U S   B I O C L I M A T O L O G I C A L   D A T A

Section G: World meteorological organization

WORLD METEOROLOGICAL ORGANIZATION AND INTERNATIONAL SOCIETY OF BIOCLIMATOLOGY AND BIOMETEOROLOGY TO COLLABORATE

by

Frederick Sargent, II, M.D. (U.S.A.)
President I.S.B.B.

In June of this year the president of this Society received a letter from the Secretary-General of the World Meteorological Organization informing him that the Executive Committee of WMO had, in Resolution 15 (EC-XI), directed the Secretary-General to (1) collaborate with this Society and (2) investigate the most proper and efficient manner in which bioclimatology and biometeorology of man may be integrated into the activities of WMO. The resolution, the letter from the Secretary-General to the President, and the President's reply are reproduced below.

Some comments on the background of this resolution may be of interest. Since the formal founding of this Society in August, 1956, at UNESCO H.Q. in Paris excellent relations have been maintained with WMO. Observers from WMO have attended the congresses of I.S.B.B. and likewise observers from I.S.B.B. have attended the meetings of the Commissions on Climatology and Agricultural Meteorology. At the 2nd Congress of the Commission on Climatology, Washington, D.C., January, 1957, the president of I.S.B.B. urged WMO to collaborate with I.S.B.B. This Society could act in an advisory capacity and keep WMO informed on current developments in bioclimatology and biometeorology. Similar suggestions have been made by Mr. P.M.A. Bourke at more recent meetings of the Commission on Agricultural Meteorology at Warsaw and Geneva and by the Secretary-General of I.S.B.B. at the recent world conference of W.M.O. itself at Geneva. Now these suggestions have born fruit. Just what form the collaboration will finally take cannot be foretold.

The aims of the Executive Board are to integrate the efforts of the many UN agencies engaged or interested in bioclimatology and biometeorology, to avoid unnecessary duplication of work, and encourage closer collaboration among these agencies. It may be noted in this regard that progress is also being made toward active collaboration with the World Health Organization. The Board hopes to be able to report further developments along these lines by September, 1960.

W O R L D   M E T E O R O L O G I C A L   O R G A N I Z A T I O N

Resolution 15 (EC-XI)

BIOCLIMATOLOGY AND BIOMETEOROLOGY OF MAN

THE EXECUTIVE COMMITTEE,

NOTING,

1) Recommendation 6 (CAgM-II);

2) The wish expressed by Third Congress that more attention should be given to bioclimatology and biometeorology;

DIRECTS the Secretary-General,

1) To collaborate with and to support the International Society of Bioclimatology and Biometeorology;

2) To investigate, in consultation with the Presidents of the Technical Commissions concerned, the most proper and efficient manner in which bioclimatology and biometeorology of man may be integrated into the activities of WMO.

ORGANISATION METEOROLOGIQUE MONDIALE WORLD METEOROLOGICAL ORGANIZATION

SECRETARIAT: AVENUE DE LA PAIX, CAMPAGNE RIGOT-GENEVE

no. 6.683/59/DT/CL/BI GENEVE 11 June 1959
Annexes: 1

Dear Sir,

I take pleasure in sending you herewith a copy of Resolution 15 (EC-XI), passed by the recent eleventh session of the Executive Committee of the World Meteorological Organization and entitled "Bioclimatology and Biometeorology of Man".

I have approached the Presidents of two of the WMO Commissions concerned namely the Commission for Climatology (CCl) and the Commission for Agricultural Meteorology (CAgM), suggesting that the former might wish to establish a working group to deal with this important and many-sided problem.

I shall not fail to keep you informed on further developments in this matter. In the meantime I should welcome any comment or suggestion you might wish to make in this connexion.

Yours sincerely,

(D.A. Davies)
Secretary-General

The President,
International Society of
Bioclimatology and Biometeorology,
Dept. of Physiology,
524 Biology Building,
University of Illinois,
URBANA, Ill.,
U.S.A.

cc. Mr. R.G. Veryard, President of CCl, London, England.
Mr. P.M.A. Bourke, President of CAgM, Dublin, Ireland.
Mr. M.S. Kulik, Vice-President of CAgM, Moskva, U.S.S.R.

INTERNATIONAL SOCIETY OF BIOCLIMATOLOGY AND BIOMETEOROLOGY

June 23, 195

Dr. D.A. Davies
Secretary-General
World Meteorological Organization
Avenue De La Paix
Campagne Rigot - Geneva.

Dear Doctor Davies: Re: 6.683/59/DT/CL/BI

I was truly gratified to receive your letter of 11 June in which you informed me that the Executive Committee of the World Meteorological Organization had resolved to develop a program related to human bioclimatology and collaborate with this Society. I am confident that much useful work can be accomplished by this collaboration, and I look forward to hearing from Mr. Veryard and Mr. Bourke on this matter.

I should like to pass on a few thoughts regarding the program which might be adopted. Insofar as a formal working group is concerned, I think that that would represent unnecessary duplication of the activities of this society. I would propose rather that there be a liaison committee comprised of representatives of the society who might formally report to WMO regarding the work of this society and who would assist you in answering queries addressed to WMO on bioclimatological matters. The liaison committee might have four members, one from human bioclimatology, one from agricultural bioclimatology, one from animal bioclimatology, and one from entomological bioclimatology.

The long-range goals of the society should perhaps become the focus of the program of collaboration. These goals, as I see them, are (1) to achieve a critical synthesis of what is actually solid fact and what is fancy speculation and assumption in the area of bioclimatology; (2) to document the past and current literature of bioclimatology; (3) to work with existing abstract agencies with a view to enhancing their coverage of the literature; (4) to encourage investigation of basic and applied problems urgently in need of solution; and (5) to stimulate graduate training in this complex interdisciplinary subject. We hope to achieve these ends through our journal, our congresses, and our technical committees. If active collaboration with WMO can focus on these broad goals, their more rapid attainment should be assured.

This society will hold its next congress in September, 1960. It is my sincere hope that by that time, I can report to the society that this WMO resolution has borne fruit. For the moment, please be assured of my most enthusiastic support for the ideas represented in your letter.

Yours sincerely,

Frederick Sargent, II, M.D.
President.

cc. Dr. S.W. Tromp
Mr. R.G. Veryard
Mr. P.M.A. Bourke

MISCELLANEOUS BIOCLIMATOLOGICAL DATA

Section B: Reports of Congresses of National Bioclimatological Societies

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PROGRAM OF SYMPOSIUM ON BIOCLIMATOLOGY*

during the 176th National Meeting of the American Meteorological Society held jointly with the section of Meteorology, American Geophysical Union at WASHINGTON, D.C., U.S.A. ON 5 MAY 1959 AT THE NATIONAL ACADEMY OF SCIENCES

Chairman: Prof. Konrad J.K. Buettner

BIOCLIMATIC WORK IN THE U.S. WEATHER BUREAU: by H.E. LANDSBERG, Office of Climatology, U.S. Weather Bureau, Washington, D.C.

ROLE OF BIOCLIMATOLOGY IN THE ARMED FORCES: by DOUGLAS H.K. LEE, M.D., U.S. Quartermaster Research & Engineering Centre, Natick, Mass.

CHANGES IN IDEAS ON CLIMATIC ORIGIN OF DISEASE: by FREDERICK SARGENT, II, M.D., Dept. of Physiology, University of Illinois, Urbana, Ill.

THE EMISSION AND DISPERSION OF RAGWEED POLLEN: by JAMES B. HARRINGTON, Jr. and A. NELSON DINGLE, Meteorological Laboratory, University of Michigan, Ann Arbor, Mich.

ELECTRIC SPACE CHARGES AND HUMAN HEALTH: by IGHO HART KORNBLUEH, M.D., The Graduate Hospital, University of Pennsylvania, Philadelphia, Pa.

WEATHER IN PUBLIC HEALTH RESEARCH: by NICHOLAS E. MANOS, Air Pollution Program, Dept. of Health, Education and Welfare, Washington, D.C.

CONDENSATION DROPLETS AND IONIZATION PATTERN IN SUBMARINE ATMOSPHERE: by K.E. SCHAEFFER, M.D., U.S. Naval Medical Research Laboratory, New London, Conn.

HOW GOOD OR BAD IS WEATHER FOR NORMAL AND SICK PEOPLE ?: by KONRAD J.K. BUETTNER, Dept. of Meteorology and Climatology, University of Washington, Seattle, Wash.

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* Copied from "Bulletin of the American Meteorological Society", vol.40, no.4, pp. 193 - 208, April 1959.

Information concerning reports etc. can be obtained from Prof. Konrad J.K. Buettner, Professor of Meteorology and Climatology, University of Washington, Seattle, Washington, U.S.A.

M I S C E L L A N E O U S   B I O C L I M A T O L O G I C A L   D A T A

Section G: International Organizations

THIRD SESSION OF THE WORLD METEOROLOGICAL CONGRESS
at
the Palais des Nations, Geneva, Switzerland
from 1 - 28 April 1959

On 22 August 1958 the I.S.B.B. received an invitation from the Secretary-General of the World Meteorological Organization, Mr. D.A. Davies, to designate an observer who would represent the I.S.B.B. at the third session of the W.M.O. at Geneva.

During the first part of the Congress Prof. Dr. H. Berg (Univ. of Köln) attended the Congress during 2 days as an observer of I.S.B.B. The Secretary of I.S.B.B., Dr. S.W. Tromp, attended the Congress from 15 - 18 April 1959.

At the second session of the Commission for Agricultural Meteorology of the World Meteorological Organization at Warsaw (Poland) (29 Sept.-17 Oct. 1958) (see report of Dr. Zofia Pieslak, I.J.B.B. vol. III, 1959, part VII, sect. G), a resolution was accepted (Recommendation 6 CAgM, Cg-III/Doc.27, Appendix E) in which it was suggested that "the W.M.O. Congress in Geneva should consider the most appropriate manner of incorporating Bioclimatology and Biometeorology of man into their activities". In adopting this recommendation CAgM expressed the view that the terms of reference of CAgM itself should not be extended to cover this new field, as the Commission already has a very heavy programme.

In the Report to the third World Meteorological Congress in Geneva by Mr. P.M.A. Bourke, President of the Commission for Agricultural Meteorology (Cg-III/Doc.51, 16-1-1959), on page 6, point 8.2, the following statement was made:
"The Commission considered that the subject of meteorology as applied to man, in health and disease, should be given a place amongst the activities of W.M.O., and recommended that Congress should consider the most appropriate way in which this might be done. It was considered, in view of the heavy programme of CAgM, that the terms of reference of this Commission could not be extended to include responsibility for meteorological aspects of mankind, in addition to plants and animals, without serious repercussions on its present field of activity".

In document Cg-III/Doc.112 (10-4-1959), submitted to the third W.M.O. Congress by the Secretary -General, letters were published from F.A.O. and Unesco concerning proposals for joint action with W.M.O. in the field of Agroclimatology and Bioclimatology.

These various documents were discussed on 18 April 1959 after the observer of I.S.B.B. had been welcomed by the Chairman of the Commission for Agricultural Meteorology and an opportunity was given to the Secretary-General of I.S.B.B. to explain to the Delegates of the Third Congress of W.M.O. the purpose, the organization and the various activities of the I.S.B.B.

On behalf of I.S.B.B. Dr. Tromp concluded his statement by expressing the desire of the members of I.S.B.B., that one of the means of having a more permanent close contact with W.M.O. would be the creation of a permanent working group on Bioclimatology and Biometeorology in W.M.O. As a result of these discussions the Chairman of the Committee on Technical Questions prepared document Cg-III/Doc.160 (23-4-1959) to the Plenary.
In paragraph 2 of this document the following statement was made:
"With regard to the question of human biometeorology dealt with in paragraph 8.2 of Cg-III/Doc. 51, the President of CAgM stressed the need for close liaison with the International Society for Bioclimatology and Biometeorology (I.S.B.B.) and suggested that it might be useful to organize a joint symposium with W.H.O. in conjunction with the I.S.B.B. on relations between meteorology and health. The representative of I.S.B.B., Dr. Tromp, informed the Committee that the Society had been founded in 1956 and it already had a membership of about 500 scientists, of which approximately one-third were meteorologist from 49 different countries. The members served in an individual capacity and all the work of the Society was done voluntarily. I.S.B.B. had set up a number of committees whose work was closely related to that of CCl and CAgM. He felt that it would be useful to have a Working Group on Bioclimatology and Biometeorology within W.M.O.".

In paragraph 3 of this document "the President of CCl (Commission of Climatology) pointed out that the terms of reference of his Committee included the application of climatological data to man, his comfort and his activities. CCl was, therefore, very interested in the work of I.S.B.B.

A great deal of knowledge had been acquired in several countries on bioclimatology and biometeorology and the important thing was that in these fields meteorologists must work with scientists in other disciplines, such as physiologists, agriculturalists and physicians".

The Committee on Technical Questions recommended to Plenary that the following text be included in the General Summary of the work of the Third Session of the Congress of W.M.O.:

"Congress reviewed the activities of the Commission for Agricultural Meteorology outlined in the report of the President of the Commission. It was noted with satisfaction that all the working groups established at the second session of the Commission had been given specific terms of reference with well-defined tasks. Congress agreed that it was very desirable that a session of the Working Group on the Guide to Agricultural Meteorological Practices should be arranged, at which the Chairmen of the other working groups concerned with the preparation of the Guide should be present.

Congress learned with interest of the activities of the International Society for Bioclimatology and Biometeorology and considered that this Society had done some very useful work in the short time which had elapsed since its creation. W.M.O. should continue to collaborate with and to support the International Society of Bioclimatology and Biometeorology in every possible way".

MISCELLANEOUS BIOCLIMATOLOGICAL DATA
Section G: International Organizations

REPORT OF THE SECOND SESSION OF THE COMMISSION FOR AGRICULTURAL METEOROLOGY OF THE WORLD METEOROLOGICAL ORGANIZATION AT WARSAW (Poland)*
(29 Sept. - 17 Oct. 1958)

The second Commission for agricultural meteorology of the World Meteorological Organization was held in Warsaw from 29. IX to 17. X 1958. Thirty-two countries from all parts of the world sent their delegates and experts. The Session was opened by the Minister of Navigation and Water Administration who directs the Polish Hydro-meteorological Service. At the inauguration were also present the Vice-Minister, members of diplomatic corps, representatives of particular health-resorts and guests. Dr. J.J. Burgos, President of the Commission for Agricultural Meteorology, was Chairman of the Commission. The General Secretariat of WMO was represented by Dr. O. Ashford. At the Session were also present representatives of international scientific associations, the International Geographical Union, International Society of Soil Science and International Society of Bioclimatology and Biometeorology.

When the official part ended, national representatives grouped into two committees, which worked simultaneously during the subsequent days and discussed a great many essential problems of agricultural meteorology. These included the necessity for meteorological observations in agriculture and the instruments and methods of measurement. It is worth while stressing the fact that the soil climate and especially the water conditions of agricultural soils awoke a particular interest. A topic of animated discussion was the method for measuring the water balance of soil and plant, the ways for ensuring that plants obtain the necessary quantity of soil moisture, investigation of the influence of soil moisture on the wear of agricultural machines, on fuel consumption, and so on.

That long hours were sacrificed to the problems of agro-hydrology - embracing extremely important problems of agriculture and practical forestry - can be explained by the fact that this branch of agro-meteorology is not yet sufficiently developed in many countries.

Matters of information and forecasting, with proper classification of meteorological forecasts, were broadly discussed; the first was concerned with a synoptic approach, the second was of interest to agro-meteorologists. A great deal of time was also devoted to agro-climatic classifications and to world agro-climatic atlas.

The problems of teaching agricultural meteorology aroused an animated and lengthy discussion. The urgent necessity for the training of cadres of young agro-meteorologists as well as the matter of textbooks was stressed. The lack of textbooks can be felt, and it is well known that most of the textbooks of meteorology appearing on the market are adjusted to the needs of the farmer and only seldom to those of agricultural meteorology. Although a model textbook, produced under the auspices of the WMO would be welcome, it has been decided to give priority to the preparation of an agro-meteorological guide. Published by WMO, this will contain technical details of instruments and methods of agro-meteorological measurement. The contents of the guide will most probably in future form a part of the above-mentioned textbook on agricultural meteorology. The countries concerned have themselves to start work on this.

Among other points the Session considered the significance of biometeorology and bioclimatology as parts of established meteorology and hence the necessity for closer collaboration between WMO and ISBB. As a result of the discussion, it was decided to ask the next Congress of WMO to examine the possibility of spreading the scope of activity of WMO by extending its responsibility to studies in the domain of the bioclimatology and biometeorology of man. The best course seems to be the establishment of a special technical commission to deal with these problems.

Some of the subjects discussed at the Session, on account of their importance and difficulty, were transferred to the attention of specially created study-groups. These working groups will deal with the problems entrusted to them during the intersessional period.

* Report prepared by Dr. Zofia Piéslak, agro-meteorological section of the Instytut Hydrologiczwo- klimatologiczny, Ul. Podlésna 61, Warszawa 32, Poland.

At the last plenary meeting of the Session a long speech was made by Dr. J.J.Burgos, the retiring President of the Commission of Agricultural Meteorology, who had held office for two terms over a period of seven years. At the close of this speech, Dr. Burgos expressed his thanks to all who had helped him up to the very last day, in the performance of his difficult and responsible duties. Dr. M.A. Bourke (Meteorological Service of Ireland) was elected President of the Commission for the period of the new term, Dr. H. Geslin, the retiring Assistant Vice-President was replaced by Mr. M.S. Kulik (Central Institute of Forecasts - U.R.S.).

The delegates present at the Second Session of the Commission of agricultural meteorology made an excursion to Białowieza and Mazury, which gave them an opportunity to become acquainted with some of the stations of the Polish Hydro-meteorological Service. The delegates also visited the agro-meteorological research station at Brwinów near Warsaw.

Section H : Advertisements